SECTION B. TECHNICAL NOTES

Survey Methodology[7]

Reporting Unit

The reporting unit for the Survey of Industrial Research and Development is the company[8], defined as a business organization of one or more establishments under common ownership or control. The survey includes two groups of enterprises: (1) companies known to conduct R&D, and (2) a sample representation of companies for which information on the extent of R&D activity is uncertain.

Frame Creation

The Standard Statistical Establishment List (SSEL), a Bureau of the Census compilation that contains information on more than 3 million establishments with paid employees, was the target population from which the frame used to select the 1998 survey sample was created (see table B-1 for population and sample sizes). For companies with more than one establishment, data were summed to the company level and the resulting company record was used to select the sample and process and tabulate the survey data.

After data were summed to the company level, each company then was assigned a single Standard Industrial Classification (SIC) code based on payroll. The method used followed the hierarchical structure of the SIC coding system. The company was first assigned to the economic division, manufacturing or nonmanufacturing, that accounted for the highest percentage of its aggregated payroll. Then the company was assigned the 2-digit SIC code that accounted for the highest percentage of its payroll within the assigned economic division. Finally, the company was assigned the 3-digit SIC code that accounted for the highest percentage of its payroll within the assigned 2-digit industry. Assignment below the three-digit level was not done because of the concentration of

R&D in relatively few industries and disclosure concerns (see below for detailed discussions of both issues).

The frame from which the survey sample was drawn included all for-profit companies classified in nonfarm industries. For surveys prior to 1992, the frame was limited to companies above certain size criteria based on number of employees.[9] These criteria varied by industry. Some industries were excluded from the frame because it was believed that they contributed little or no R&D activity to the final survey estimates. For the 1992 sample, new industries were added to the frame,[10] and the size criteria were lowered considerably and applied uniformly to firms in all industries. As a result, nearly 2 million enterprises with 5 or more employees were given a chance of selection for subsequent samples, including the 1998 sample. For comparison, the frame for the 1987 sample included 154,000 companies of specified sizes and industries.

Defining Sampling Strata

A fundamental change initiated in 1995 and repeated for subsequent samples was the redefinition of the sampling strata. For the survey years 1992–94, 165 sampling strata were established, each stratum corresponding to one or more 3-digit-level SIC codes. The objective was to select sufficient representation of industries to determine whether alternative or expanded publication levels were warranted. Starting with the 1995 survey, the sampling strata corresponded to publication level industry aggregations. For each year, 40 publication levels were defined. These correspond to the original 25 groupings of manufacturing industries used as sampling strata before 1992 and an additional 15 groupings of nonmanufacturing industries. Companies were assigned to strata based on their 3-digit SIC codes.

Identifying Certainty Companies

The criteria for identifying companies selected for the survey with certainty, which were most recently modified in 1996, have remained the same for subsequent surveys. To limit the growth occurring each year in the number of certainty cases within the total sample, the

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[7]Information for this section was provided by the Manufacturing and Construction Division of the U.S. Bureau of the Census, which collected and compiled the survey data for NSF. Copies of the technical papers cited can be obtained from NSF's Research and Development Statistics Program in the Division of Science Resources Studies.

[8]In the Survey of Industrial Research and Development and in the publications presenting statistics resulting from the survey, the terms "firm," "company," and "enterprise" are used interchangeably. "Industry" refers to the activity or group of activities included in the 2- or 3-digit standard industrial classifications (SICs) or groups of SICs used to array statistics resulting from the survey.

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[9]See U.S. Bureau of the Census (1994d).

[10]These industries are listed and discussed below under "Comparability of Statistics."

certainty criterion was raised for the 1996 survey from $1 million to $5 million in total R&D expenditures based on data gathered from the 1995 survey. With a fixed total sample size, there was concern that the representation of the very large noncertainty universe by a smaller sample each year would be inadequate. Before 1994, companies with 1,000 or more employees had been selected with certainty, but it was observed that the level of spending varied considerably and that many of these companies reported no R&D expenditures each year. For these reasons, it was determined that these companies should be given chances of selection based upon the size of their R&D spending if they were in the previous survey or upon an estimated R&D value if they were not. Consequently, the size criterion based on the number of employees was dropped for surveys after 1994.

FRAME PARTITIONING

Partitioning of the frame for noncertainty companies into large and small companies was first introduced in 1994 because of concern arising from a study of 1992 survey results which showed that a disproportionate number of small companies was being selected for the sample, and often assigned very large weights. These small companies seldom reported R&D activity. This disproportion was a result of the minimum probability rule (see "Sample Size" below) used as part of the independent probability proportionate to size (pps) sampling procedure employed exclusively prior to 1994 (pps is discussed in detail later under "Sample Selection"). This rule increased the probabilities of selection for several hundred thousand smaller companies. For 1994 and subsequent surveys, simple random sampling (srs) was applied to the small company partition causing the smaller companies to be sampled more efficiently than with independent pps sampling since there was little variability in their size (srs is discussed in detail later under "Sample Selection"). The large company partition continued to be sampled using independent pps sampling.

In 1994 and 1995, total company payroll was the basis for partitioning the noncertainty frame. For each industry grouping, the largest companies representing the top 90 percent of the total payroll for the industry grouping were included in the pps frame. The balance, the smaller companies comprising the remaining 10 percent of payroll for the industry grouping, were included in the srs frame.

Beginning in 1996, total company employment became the basis for partitioning the frame. The total company employment levels defining the partitions were based on the relative contribution to total R&D expenditures of companies in different employment size groups in both the manufacturing and nonmanufacturing sectors. In the manufacturing sector, all companies with total employment of 50 or more were included in the large company partition. In the nonmanufacturing sector, all companies with total employment of 15 or more were included in the large company partition. Companies in the respective sectors with employment below these values were included in the small company partition. In the 1998 survey, the large company partition contained almost 550,000 companies and the small company partition contained approximately 1.3 million companies. These counts were comparable to those in the 1997 survey (540,000 and 1.3 million, respectively).

IDENTIFYING "ZERO" INDUSTRIES

One final modification in the frame development for 1996, which was repeated for subsequent surveys, was the designation of "zero industries" in the large company partition. Zero industries were those three-digit SIC industries having no R&D expenditures reported in survey years 1992-1994—the years when estimates by three-digit SIC industry were formed. These industries remained within the scope of the survey, but only a limited sample was drawn from them because it was unlikely that these industries conducted R&D. Simple random sampling was used to control the number of companies selected from these industries.

SAMPLE SELECTION

In 1996 a significant revision in the procedure for selecting samples from the partitions led to a change in the development and presentation of estimates. The revised procedure was repeated for subsequent surveys. In 1995 the sample of companies from the large company partition was selected using probability proportionate to size sampling (see below) in each of the 40 strata (discussed previously under "Defining Sampling Strata"). Likewise, the simple random sampling of the small company partition was done for each of the 40 strata. However, beginning in 1996, the number of strata established for the small company partition was reduced to two. One stratum consisted of small companies classified in manufacturing industries and the second stratum consisted of small companies classified in nonmanufacturing industries. Simple random sampling continued as the selection method for these two strata.

The purpose of selecting the small company panel from these two strata was to reduce the variability in industry

estimates largely attributed to the random year-to-year selection of small companies by industry and the high sampling weights that sometimes occurred. As a consequence of this change, estimates for industry groups within manufacturing and nonmanufacturing were not possible from these two strata as noted on affected tables. The statistics for the detailed industry groups were based only on the sample from the large company partition. Estimates from the small company partition were included in statistics for total manufacturing, total nonmanufacturing, and all industries. For completeness, in the affected tables the estimates also were added to the categories "other manufacturing" and "other nonmanufacturing".

Probability Proportionate to Size

For this survey it would have been ideal if company size could have been determined by its R&D expenditures. Unfortunately, except for the companies that were in a previous survey or for which there was information from external sources, it was impossible to know the R&D expenditures for every firm in the universe. Consequently, the probability of selection for most companies was based on estimated R&D expenditures.

Since total payroll was known for each company in the universe, it was possible to estimate R&D from payroll using relationships derived from 1997 survey data. Imputation factors relating these two variables were derived for each industry grouping. To impute R&D for a given company, the imputation factors were applied to the company payroll in each industry grouping. A final measure was obtained by adding the industry grouping components. The effect, in general, was to give firms with large payrolls higher probabilities of selection in agreement with the assumption that larger companies were more likely to perform R&D.

Estimated R&D values were computed for companies in the small company partition as well. The aggregate of reported and estimated R&D from each company in both the large and small company partitions represented a total universe measure of 1997 R&D expenditures. However, assigning R&D to every company resulted in an overstatement of this measure. To adjust for the overstatement, the universe measure was scaled down using factors developed from the relationship between the frame measure of 1997 R&D and the final 1997 survey estimates. These factors, computed at levels corresponding to published industry levels, were used to adjust the originally imputed R&D values so that the new frame total for R&D at these levels approximated the

1997 published values. This adjustment provided for better allocation of the sample among these levels.

For 1998, the distribution of companies by payroll and estimated R&D in the large company partition was skewed as in earlier frames (i.e., the correlation of payroll and R&D was high because R&D had been estimated based on payroll). Because of this skewness, pps sampling remained the appropriate selection technique for this group except for the zero industries (discussed previously). That is, large companies had higher probabilities of selection than did small companies. However, a different approach to pps sampling was introduced for the 1998 survey. Historically, pps sampling had been accomplished using an independent sampling methodology, i.e., the selection (or nonselection) of a given company was independent of the sampling result (select or nonselect) of any other company. This implied that over repeated samplings in a given stratum, different size samples would result. This added more variability to the sample estimates. For 1998, a fixed sample size pps method was introduced. This method ensured that the sample size desired for a given stratum was achieved, thus eliminating error because of sample size variation from the sample estimates. For a given sample size, the fixed sample size method will produce more precise estimates on average than the independent method.

Simple Random Sampling

As described earlier, only two major strata were defined for samples in the small company partition, manufacturing and nonmanufacturing. The use of srs implied that each company within a stratum had an equal probability of selection. The total sample allocated to the small company partition was dependent upon the total sample specified for the survey and upon the total sample necessary to satisfy criteria established for the large partition. Once determined, the allocation of this total by stratum was made proportionate to the stratum's payroll contribution to the entire partition.

Sample Stratification and Relative Standard Error Constraints

The particular sample selected was one of a large number of samples of the same type and size that by chance might have been selected. Statistics resulting from the different samples would differ somewhat from each other. These differences are represented by estimates of sampling error or variance. The smaller the sampling error, the more precise the statistic.

Controlling Sampling Error. Historically, it has been difficult to achieve control over the sampling error of survey estimates. Efforts were confined to controlling the amount of error due to sample size variation, but this was only one component of the overall sampling error. The other component depended on the correlation between the data from the sampling frame used to assign probabilities (namely R&D values either imputed or reported in the previous survey) and the actual current year reported data. The nature of R&D is such that these correlations could not be predicted with any reliability. Consequently, precise controls on overall sampling error were difficult to achieve.

For recent surveys, primary concern was placed on controlling error for the large company partition since nearly all of the R&D activity was identified from that portion of the sample. In 1998, with the introduction of the fixed sample size sampling procedure, the component of sampling error due to sample size variation was eliminated. However, the amount of error attributable to the remaining component of the sample remained. Since there was still no way to predict how well the data from the sampling frame would correlate with actual survey data, the sample was allocated across the 40 strata in the same manner as in the past when independent sampling was used. The probabilities resulting from this allocation technique determined the sample sizes to be selected from each stratum subject to the overall sample size constraint dictated by the survey budget. Although the actual survey sampling errors could not be predicted, the parameters used to assign probabilities, and the use of the minimum probability rule resulted in a desirable number of companies being sampled from the large company partition (see "Sample Size" below).

Sampling Strata and Standard Error Estimates. A limitation of the sample allocation process for the large company partition should be noted. The constraints used to control the sample size in each stratum were based on a universe total that, in large part, was improvised. That is, as previously noted, an R&D value was assigned to every company in the frame, even though most of these companies actually may not have had R&D expenditures. The value assigned was imputed for the majority of companies in the frame and, as a consequence, the estimated universe total and the distribution of individual company values, even after scaling, did not necessarily reflect the true distribution. Assignment of sampling probability was nevertheless based on this distribution. The presumption was that actual variation in the sample

design would be less than that estimated, because many of the sampled companies have true R&D values of zero, not the widely varying values that were imputed using total payroll as a predictor of R&D. Previous sample selections indicate that in general this presumption held, but exceptions have occurred when companies with large sampling weights have reported large amounts of R&D spending. See table B-2 for a list by industry of the standard error estimates for selected items.

Nonsampling Error. In addition to sampling error, estimates are subject to nonsampling error. Errors are grouped in five categories: specification, coverage, response, nonresponse, and processing. For detailed discussions on the sources, control, and measurement of each of these types of error, see U.S. Bureau of the Census (1994b and 1994f).

SAMPLE SIZE

The parameters set to control sampling error discussed above resulted in a sample size of 18,344 companies from the large company partition. For the small company partition, two strata (manufacturing and nonmanufacturing) were identified. Also included was a separate stratum of small companies that could not be classified into an SIC because of incomplete industry identification in the SSEL. In 1998, as in the 1994 through 1997 surveys, a small number of companies was selected from this group in the hope that an accurate industry identification could be obtained at a later point. Ultimately, a final sample of 6,465 companies was selected from the small company partition. The sample initially allocated to the two strata was proportionate to its share of total payroll for the small company partition. The total sample size finally determined for the 1998 survey was 24,809. This total included an adjustment to the sample size based on a minimum probability rule and changes in the operational status of some companies. With the use of fixed sample size pps sampling for the large company partition and simple random sampling for the small company partition and the zero-industry stratum, the target sample size was met.

Minimum Probability Rule. A minimum probability rule was imposed for both partitions. As noted earlier, for the large partition, probabilities of selection proportionate to size were assigned to each company, where size was the reported or imputed R&D value assigned to each company. Selected companies received a sample weight which was the inverse of their probability. Selected companies that ultimately report R&D expenditures vastly larger than their assigned values can have adverse effects

on the statistics, which were based on the weighted value of survey responses. To lessen the effects on the final statistics, the maximum weight of a company was controlled by specifying a minimum probability that could be assigned to the company. If the probability, based on company size, was less than the minimum probability, then it was reset to this minimum value. The consequence of raising these original probabilities to the minimum probability was to raise the sample size. Similarly, a maximum weight for each stratum was established for the simple random sampling of the small company partition. If the sample size initially allocated to a stratum resulted in a stratum weight above this maximum value, then the sample size was increased until the maximum weight was achieved.

Changes in Operational Status. Between the time that the frame was created and the survey was prepared for mailing, the operational status of some companies changed. That is, they were merged with or acquired by another company, or they were no longer in business. Before preparing the survey for mailing, the operational status was updated to identify these changes. As a result, the number of companies mailed a survey form was somewhat smaller than the number of companies initially selected for the survey.

WEIGHTING AND MAXIMUM WEIGHTS

Weights were applied to each company record to produce national estimates. Within the pps partitions of the sample, company records were given weights up to a maximum of 50; for companies within the srs partitions, company records were given weights up to a maximum of 250.

SURVEY QUESTIONNAIRES

Two questionnaires are used each year to collect data for the survey. Known large R&D performers are sent a detailed questionnaire, Form RD-1.[11] The Form RD-1 requests data on sales or receipts, total employment, employment of scientists and engineers, expenditures for R&D performed within the company with Federal funds and with company and other funds, character of work (basic research, applied research, and development), company-sponsored R&D expenditures in foreign countries, R&D performed under contract by others,

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[11]Form RD-1 is a revised version of the Form RD-1L, formerly used to collect data from large R&D performers for odd-numbered years. For even-numbered years, an abbreviated questionnaire, Form RD-1S was used. Beginning in 1998 the Form RD-1L was streamlined and the odd/even-numbered year cycle abandoned.

federally funded R&D by contracting agency, R&D costs by type of expense, domestic R&D expenditures by State, energy-related R&D and foreign R&D by country. Because companies receiving the Form RD-1 have participated in previous surveys, computer-imprinted data reported by the company for the previous year are supplied for reference. Companies are encouraged to revise or update this imprinted data if they have more current information, however prior-year statistics that had been previously published were revised only if large disparities were reported.

Small R&D performers and firms included in the sample for the first time were sent Form RD-1A. This form collects the same information as Form RD-1 except for five items: Federal R&D support to the firm by contracting agency, R&D costs by type of expense, domestic R&D expenditures by State, energy-related R&D, and foreign R&D by country. It also includes a screening item that allows respondents to indicate that they do not perform R&D. No prior-year information is made available since the majority of the companies that receive the Form RD-1A have not been surveyed in the previous year.

QUESTIONNAIRE CONTENT CHANGES

For the 1996 survey year, data on federally-funded and total R&D performed under contract to others (or "contracted-out") were collected to better measure the amount of R&D performed both within and between companies. For earlier years, data were collected only on non-federally funded contracted-out R&D.

Based on information obtained from telephone interviews with a sample of respondents, a new item, R&D depreciation costs, was added to the 1998 Form RD-1. In prior years R&D depreciation was included in the "other costs" category of R&D expenditures.

Also beginning with the 1998 survey, items used to collect detailed information on the allocation of R&D expenditures by field of science and engineering and by product class, and R&D expenditures for pollution abatement were eliminated. Further, the amount of detail requested for energy-related R&D was reduced. Item nonresponse on each of these items were unacceptably high relative to their response burden.

NUMBER OF QUESTIONNAIRES SENT

Form RD-1 was mailed to companies that reported R&D expenditures of $5 million dollars or more in the 1997

survey. Nearly 1,700 companies received Form RD-1 and approximately 23,000 received Form RD-1A. Both questionnaires and the instructions provided to respondents are reproduced in section C, Survey Documents.

FOLLOW-UP FOR SURVEY NONRESPONSE

The 1998 survey questionnaires were mailed in March 1999. Recipients of Form RD-1A were asked to respond within 30 days, while Form RD-1 recipients were given 60 days. A follow-up form and letter were mailed to RD-1A recipients every thirty days if their completed questionnaire had not been received; a total of five follow-up mailings were conducted for delinquent RD-1A recipients.

A letter was mailed to Form RD-1 recipients thirty days after the initial mailing, reminding them that their completed questionnaires were due within the next 30 days. A second form and reminder letter were mailed to Form RD-1 respondents after 60 days. Two additional follow-up mailings were conducted for delinquent RD-1 recipients.

In addition to the mailings, telephone follow-up was used to encourage response from those firms ranked among the 300 largest R&D performers, based on total R&D expenditures reported in the previous survey. Table B-3 shows the number of companies in each industry or industry group that received a questionnaire and the percentage that responded to the survey.

IMPUTATION FOR ITEM NONRESPONSE

For various reasons, many firms chose to return the survey questionnaires with one or more blank items.[12] For some firms, internal accounting systems and procedures may not have allowed quantification of specific expenditures. Others may have refused to answer any voluntary questions as a matter of company policy.[13]

When respondents did not provide the requested information, estimates for the missing data were made

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[12]For detailed discussions on the sources, control, and measurement of error resulting from item nonresponse, see U.S. Bureau of the Census (1994b).

[13]All but four items—total R&D, Federal R&D, net sales, and total employment, which are included in the Census Bureau's annual mandatory statistical program—are voluntary. See further discussion under "Response Rates and Mandatory Versus Voluntary Reporting" later in this section.

using imputation algorithms. In general, the imputation algorithms computed values for missing items by applying the average percentage change for the target item in the nonresponding firm's industry to the item's prior-year value for that firm, reported or imputed. This approach, with minor variation, was used for most items.[14] Table B-4 contains imputation rates for the principal survey items.

RESPONSE RATES AND MANDATORY VERSUS VOLUNTARY REPORTING

Current survey reporting requirements divide survey items into two groups: mandatory and voluntary. Response to four data items on the questionnaires, total R&D expenditures, Federal R&D funds, net sales, and total employment, was mandatory, whereas response to the remaining items was voluntary. During the 1990 survey cycle, NSF conducted a test of the effect of reporting on a completely voluntary basis to determine if combining both mandatory and voluntary items on one questionnaire influences response rates. For this test, the 1990 sample was divided into two panels of approximately equal size. One panel, the mandatory panel, was asked to report as usual on four mandatory items with the remainder voluntary; and the other panel was asked to report all items on a completely voluntary basis. The result of the test was a decrease in the overall survey response rate to 80 percent from levels of 88 percent in 1989 and 89 percent in 1988. The response rates for the mandatory and voluntary panels were 89 percent and 69 percent, respectively. Detailed results of the test were published in *Research and Development in Industry: 1990*. For firms that reported R&D expenditures in 1998, table B-5 shows the percentage that also reported data for other selected items.

CHARACTER OF WORK ESTIMATES

Response to questions about character of work (basic research, applied research, and development) declined in the mid-1980s, and, as a result, imputation rates increased. The general imputation procedure described above became increasingly dependent upon information imputed in prior years, thereby distancing current year estimates from any reported information. Because of the increasing dependence on imputed data, NSF chose not to publish character of work estimates in 1986. The imputation procedure used to develop these estimates was revised in 1987 for use with later data and differs from the general imputation approach. The new method calculated the

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[14]For detailed descriptions and analyses of the imputation methods and algorithms used, see U.S. Bureau of the Census (1994c).

character of work distribution for a nonresponding firm only if that firm reported a distribution within a 5-year period, extending from 2 years before to 2 years after the year requiring imputation. Imputation for a given year was initially performed in the year the data were collected and was based on a character of work distribution reported in either of the 2 previous years, if any. It was again performed using new data collected in the next 2 years. If reported data followed no previously imputed or reported data, previous period estimates were inserted based on the currently reported information. Similarly, if reported data did not follow 2 years of imputed data, the 2 years of previously imputed data were removed. Thus, character of work estimates were revised as newly reported information became available and were not final for 2 years following their initial publication.

Beginning with 1995, previously estimated values were not removed for firms that did not report in the third year, nor were estimates made for the 2 previous years for firms reporting after 2 years of nonresponse. This process was changed because, in the prior period, revisions were minimal. Estimates continued to be made for 2 consecutive years of nonresponse and discontinued if the firm did not report character of work in the third year. If no reported data were available for a firm, character of work estimates were not imputed. As a consequence, only a portion of the total estimated R&D expenditures were distributed at the firm level. Those expenditures not meeting the requirements of the new imputation methodology were placed in a "not distributed" category. Table B-6 shows the character of work estimates along with the "not distributed" component for 1998.

NSF's objective in conducting the survey has always been to provide estimates for the entire population of firms performing R&D in the United States. However, the revised imputation procedure would no longer produce such estimates because of the "not distributed" component. A baseline estimation method thus was developed to allocate the "not distributed" amounts among the character of work components. In the baseline estimation method, the "not distributed" expenditures were allocated by industry group to basic research, applied research, and development categories using the percentage splits in the distributed category for that industry. The allocation was done at the lowest level of published industry detail only; higher levels were derived by aggregation, just as national totals were derived by aggregation of individual industry estimates, and result in higher performance shares for basic and applied research and lower estimates for development's share than would have been calculated using the previous method. The estimates of basic research, applied research, and development provided in the tables in section A were calculated using the baseline estimation method.

STATE ESTIMATES

Form RD-1 requested data on the cost of R&D performed for states in which a company's R&D facilities were located. An independent source, the *Directory of American Research and Development*, published by the Data Base Publishing Group of the R. R. Bowker Company, was used in conjunction with survey results to estimate R&D expenditures by state for companies that did not provide this information. The information on scientists and engineers published in the directory was used as a proxy indicator of the proportion of R&D expenditures within each state. R&D expenditures by state were estimated by applying the distribution of scientists and engineers by state from the directory to total R&D expenditures for these companies. These estimates were included with reported survey data to arrive at published estimates of R&D expenditures for each state.

COMPARABILITY OF STATISTICS

This section summarizes survey procedures and practices that may have affected the comparability of statistics produced from the Survey of Industrial Research and Development over time and with other statistical series.[15]

REVISIONS TO HISTORICAL AND IMMEDIATE PRIOR YEAR STATISTICS

Revisions to historical statistics usually have been made because of changes in the industry classification of companies caused by changes in payroll composition detected when a new sample was drawn. Various methodologies have been adopted over the years to revise, or backcast, the data when revisions to historical statistics have become necessary. Documented revisions to the historical statistics from post-1967 surveys through 1992 are summarized in NSF (1994) and in annual reports for subsequent surveys. Detailed descriptions of the specific revisions made to the statistics from pre-1967 surveys are scarce, but U.S. Bureau of the Census (1995) summarizes some of the major revisions.

Changes to reported data can come from three sources: respondents, analysts involved in survey and statistical processing, and the industry reclassification process. Prior to 1995, routine revisions were made to prior year statistics based on information from all three sources. Consequently, results from the current year survey were used not only to develop current year statistics, but also to revise immediate prior year statistics. Beginning with the 1995 survey, this practice was discontinued. The reasons for discontinuation of this practice were annual sampling, continual strengthening of sampling methodology, and improvements in data verification, processing, and nonresponse follow-up. Moreover, it was not clear that respondents or those who processed the survey results had any better information a year after the data were first reported. Thus, it was determined that routinely revising published survey statistics increased the potential for error and often confused users of the statistics. Revisions are now made to historical and immediate prior year statistics only if substantive errors are discovered.

YEAR-TO-YEAR CHANGES

Comparability from year to year may be affected by new sample design, annual sample selection, and industry shifts.

SAMPLE DESIGN

By far the most profound influence on statistics from recent surveys occurred when the new sample design for the 1992 survey was introduced. Revisions to the 1991 statistics were dramatic (see *Research and Development in Industry: 1992* for a detailed discussion). While the allocation of the sample was changed somewhat, the sample designs used for subsequent surveys were comparable to the 1992 sample design in terms of size and coverage.

ANNUAL SAMPLE SELECTION

With the introduction of annual sampling in 1992, more year-to-year change has resulted than when survey panels were used. There are two reasons why this was so. First, changes in classification of companies not surveyed were not reflected in the year-to-year movement. Prior to annual sampling, a wedging operation—which was performed when a new sample was selected—was a means of adjusting the data series to account for the changes in classification that occurred in the frame (see the discussion on wedging later under "Time Series Analyses"). Second, yearly correlation of R&D data was lost when independent samples were drawn each year.

INDUSTRY SHIFTS

The industry classification of companies is redefined each year with the creation of the sampling frame. By redefining the frame, the sample reflects current distributions of companies by size and industry. A company may move from one industry to another because of either changes in its payroll composition, which is used to determine the industry classification code (see previous discussion under "Frame Creation"); changes in the industry classification system itself; or changes in the way the industry classification code was assigned or revised during survey processing.

A company's payroll composition can change because of the growth or decline of product or service lines, the merger of two or more companies, the acquisition of one

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[15]See also U.S. Bureau of the Census (1995).

company by another; divestitures; or the formation of conglomerates. Although an unlikely occurrence, a company's industry designation could be reclassified yearly with the introduction of annual sampling in 1992. The result is that a downward movement in R&D expenditures in one industry is balanced by an upward movement in another industry from one year to the next.

From time to time, the SIC coding system, which is used by most Federal agencies that publish industry statistics, is revised to reflect the changing composition of U.S. industry. For statistics developed for 1988–91 from the 1988–91 surveys, companies retained the industry classifications assigned for the 1987 sample. These classifications were based on the 1977 SIC system. The last major revision of the SIC system was in 1987. This new system has been used to classify companies in all of the post-1991 surveys.

The method used to classify firms during survey processing was revised slightly in 1992. Research has shown that the impact on individual industry estimates was minor.[16] The current method used to classify firms was discussed previously under "Frame Creation." Methods used for past surveys are discussed in U.S. Bureau of the Census (1995).

CAPTURING SMALL AND NONMANUFACTURING R&D PERFORMERS[17]

Before the 1992 survey, the sample of firms surveyed was selected at irregular intervals.[18] In intervening years, a panel of the largest firms known to perform R&D was surveyed. For example, a sample of about 14,000 firms was selected for the 1987 survey. For the 1988–91 studies, about 1,700 of these firms were resurveyed annually; the other firms did not receive questionnaires, and their R&D data were estimated. This sample design was adequate during the survey's early years because R&D performance was concentrated in relatively few manufacturing industries. However, as more and more firms began entering the R&D arena, the old sample design

proved increasingly deficient because it did not capture births of new R&D-performing firms. The entry of fledgling R&D performers into the marketplace was completely missed during panel years. Additionally, beginning in the early 1970s, the need for more detailed R&D information for nonmanufacturing industries was recognized. At that time, the broad industry classifications "miscellaneous business services" and "miscellaneous services" were added to the list of industry groups for which statistics were published. By 1975, about 3 percent of total R&D was performed by firms in nonmanufacturing industries.

During the mid-1980s, there was evidence that a significant amount of R&D was being conducted by an increasing number of nonmanufacturing firms; again, the number of industries used to develop the statistics for nonmanufacturers was increased. Consequently, since 1987 the annual reports in this series have included separate R&D estimates for firms in the communication, utility, engineering, architectural, research, development, testing, computer programming, and data processing service industries; hospitals; and medical labs. Approximately 9 percent of the estimated industrial R&D performance during 1987 was undertaken by nonmanufacturing firms.

After the list of industries for which statistics were published was expanded, it became clear that the sample design itself should be changed to reflect the widening population of R&D performers among firms in the nonmanufacturing industries[19] and small firms in all industries so as to account better for births of R&D-performing firms and to produce more reliable statistics. Beginning with the 1992 survey, NSF decided to (1) draw new samples with broader coverage annually, and (2)

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[16]The effects of changes in the way companies were classified during survey processing are discussed in detail in U.S. Bureau of the Census (1994e and 1994a).

[17]See also NSF (1994, 1995, and 1996a).

[18]Until 1967, samples were selected every 5 years. Subsequent samples were selected for 1971, 1976, 1981, and 1987.

[19]For the 1992 survey, 25 new nonmanufacturing industry and industry groups were added to the sample frame: agricultural services (SIC 07); fishing, hunting, and trapping (09); wholesale trade–nondurables (51); stationery and office supply stores (5112); industrial and personal service paper (5113); groceries and related products (514); chemicals and allied products (516); miscellaneous nondurable goods (519); home furniture, furnishings, and equipment stores (57); radio, TV, consumer electronics, and music stores (573); eating and drinking places (581); miscellaneous retail (59); nonstore retailers (596); real estate (65); holding and other investment offices (67); hotels, rooming houses, camps, and other lodging places (70); automotive repair, services, and parking (75); miscellaneous repair services (76); amusement and recreation services (79); health services (80); offices and clinics of medical doctors (801); offices and clinics of other health practitioners (804); miscellaneous health and allied services not elsewhere classified (809); engineering, accounting, research, management, and related services (87); and management and public relations services (874).

increase the sample size to approximately 25,000 firms.[20] As a result of the sample redesign, for 1992 the reported nonmanufacturing share was (and has continued to be) 25-30 percent of total R&D.[21]

Time-Series Analyses

As discussed earlier, the statistics resulting from this survey are better indicators of changes in, rather than absolute levels of, R&D spending and personnel. Nevertheless, the statistics are often taken to be a continuous time series prepared using the same collection, processing, and tabulation methods. Such uniformity has not been the case. Since the survey was first fielded, improvements have been made to increase the reliability of the statistics and to make the survey results more useful. To that end, past practices have been changed and new procedures instituted. Preservation of the comparability of the statistics has, however, been an important consideration in making these improvements. Nonetheless, changes to survey definitions, the industry classification system, and the procedure used to assign industry codes to multi-establishment companies have had some, though not substantial, effects on the comparability of statistics.[22]

The aspect of the survey that had the greatest effect on comparability was the selection of samples at irregular intervals (i.e., 1967, 1971, 1976, 1981, 1987, and 1992) and the use of a subset or panel of the last sample drawn to develop statistics for intervening years. As discussed earlier, this practice introduced cyclical deterioration of the statistics. As compensation for this deterioration, periodic revisions were made to the statistics produced from the panels surveyed between sample years. Early in the survey's history, various methods were used to make these revisions.[23] After 1976 and until the 1992 advent of annual sampling, a linking procedure called wedging was used.[24] In wedging, the 2 sample years on each end of a series of estimates served as benchmarks in the algorithms used to adjust the estimates for the intervening years.

For a full discussion of the mathematical algorithm used for the wedging process that linked statistics from the 1992 survey with those from the 1987 survey, see U.S. Bureau of the Census (1994g). In general, wedging

takes full advantage of the fact that in the first year of a new panel [when a new sample is selected], both current year and prior-year estimates are derived. Thus, two independent estimates exist for the prior year. The estimates from the new panel are treated as superior primarily because the new panel is based on updated classifications [the industry classifications in the prior panel are frozen] and is more fully representative of the current universe (the prior panel suffers from panel deterioration, especially a lack of birth updating). The limitations in the prior panel caused by these factors are naturally assumed to increase with time, so that in the revised series, we desire a gradual increase in the level or revision over time which culminates in the real difference observed between the two independent sample estimates of the prior year. At the same time, we desire that the annual movement of the original series be preserved to the degree possible in the revised series (U.S. Bureau of the Census, 1994).

To that end, the wedging algorithm does not change estimates from sample years and adjusts estimates from panel years, recognizing that deterioration of the panel is progressive over time. One of the primary reasons for deciding to select a new sample annually rather than at irregular intervals was to avoid applying global revision processes such as wedging. Consequently, the 1992 survey was intended to be the last one affected by the wedging procedure.

Comparisons to Other Statistical Series

NSF collects data on federally financed R&D from both Federal funding agencies—using the Survey of Federal Funds for Research and Development—and from performers of the work-industry, Federal labs, universities, and other nonprofit organizations—using the Survey of Industrial Research and Development and other surveys. As reported by Federal agencies, NSF publishes data on Federal R&D budget authority and outlays, in addition to Federal obligations. These terms are defined below:[25]

[20]Annual sampling also remedies the cyclical deterioration of the statistics that results from changes in a company's payroll composition because of product line and corporate structural changes.

[21]See also NSF (1997a and 1998a).

[22]For discussions of each of these changes, see U.S. Bureau of the Census (1994g); for considerations of comparability, see U.S. Bureau of the Census (1994e and 1993).

[23]See U.S. Bureau of the Census (1995).

[24]The process was dubbed wedging because of the wedgelike area produced on a graph that compares originally reported statistics with the revised statistics that resulted after linking.

[25]See also NSF (1997b).

- *Budget authority* is the primary source of legal authorization to enter into financial obligations that will result in outlays. Budget authority most commonly is granted in the form of appropriations laws enacted by Congress with the approval of the president (NSF 1998b).

- *Obligations* represent the amounts for orders placed, contracts awarded, services received, and similar transactions during a given period, regardless of when the funds were appropriated or when future payment of money is required.

- *Outlays* represent the amounts for checks issued and cash payments made during a given period, regardless of when the funds were appropriated or obligated.

National R&D expenditure totals in NSF's *National Patterns of R&D Resources* report series are primarily constructed with data reported by performers and include estimates of Federal R&D funding to these sectors. But until performer-reported survey data on Federal R&D expenditures are available from industry and academia, data collected from the Federal agency funders of R&D were used to project R&D performance. When survey data from the performers subsequently are tabulated, as they were for this report, these statistics replace the projections based on funder expectations. Historically, the two survey systems have tracked fairly closely. For example, in 1980, performers reported using $29.5 billion in Federal R&D funding, and Federal agencies reported total R&D funding between $29.2 billion in outlays and $29.8 billion in obligations (NSF 1996b). In recent years, however, the two series have diverged considerably. The difference in the Federal R&D totals appears to be concentrated in funding of industry, primarily aircraft and missile firms, by the Department of Defense. Overall, industrial firms have reported significant declines in Federal R&D support since 1990 (see table A-1), while Federal agencies have reported level or slightly increased funding of industrial R&D (NSF 1996b). NSF is identifying and examining the factors behind these divergent trends.

Table B-1. Number of companies in the target population and selected for the sample, by industry: 1998

Industry	SIC code	Companies in target population	1998 survey Companies selected for 1998 sample	Noncertainties[1]	Certainties[2]	Companies with reported or imputed R&D expenditures for 1998 Greater than or equal to $5 million	Less than $5 million	Companies that reported no R&D expenditures for 1998	Other companies[3]
All industries...............................		1,817,225	24,809	23,175	1,634	1,655	1,671	18,028	3,455
Manufacturing...........................		182,064	4,836	3,837	999	1,011	1,042	2,167	616
Food, kindred, and tobacco products...................….……..	20,21	2,657	234	192	42	40	77	87	30
Textiles and apparel..........................	22,23	3,468	186	172	14	13	54	87	32
Lumber, wood products, and furniture....................….	24,25	3,342	225	211	14	19	54	121	31
Paper and allied products..................	26	1,233	74	47	27	28	20	22	4
Chemicals and allied products...........	28	1,288	210	61	149	151	31	13	15
Industrial chemicals......................	281–82,286	315	63	8	55	56	2	2	3
Drugs and medicines....................	283	295	60	5	55	53	3	2	2
Other chemicals...........................	284–85,287–89	678	87	48	39	42	26	9	10
Petroleum refining and extraction................................	13,29	1,935	62	46	16	18	4	34	6
Rubber products...............................	30	2,711	241	198	43	46	93	69	33
Stone, clay, and glass products.........	32	1,292	60	45	15	12	20	20	8
Primary metals................................	33	1,288	125	99	26	29	43	37	16
Ferrous metals and products........	331–32,3398–99	684	72	58	14	16	25	22	9
Nonferrous metals and products.................................	333–36	604	53	41	12	13	18	15	7
Fabricated metal products.................	34	4,808	456	421	35	37	171	176	72
Machinery..	35	4,841	491	323	168	171	152	97	71
Office, computing, and accounting machines...............	357	313	83	32	51	50	16	6	11
Other machinery, except electrical................................	351–56,358–59	4,528	408	291	117	121	136	91	60
Electrical equipment..........................	36	2,883	367	156	211	211	68	39	49
Radio and TV receiving equipment.............................	365	105	16	12	4	5	9	1	1
Communication equipment...........	366	365	68	8	60	58	2	1	7
Electronic components.................	367	1,289	156	62	94	92	29	17	18
Other electrical equipment...........	361–64,369	1,124	127	74	53	56	28	20	23

See explanatory information and SOURCE at end of table.

Table B-1. Number of companies in the target population and selected for the sample, by industry: 1998

Industry	SIC code	Companies in target population	1998 survey Companies selected for 1998 sample	Noncertainties[1]	Certainties[2]	Companies with reported or imputed R&D expenditures for 1998 Greater than or equal to $5 million	Less than $5 million	Companies that reported no R&D expenditures for 1998	Other companies[3]
Transportation equipment..................	37	1,526	89	32	57	56	11	18	4
Motor vehicles and motor vehicles equipment..................	371	809	42	17	25	25	7	8	2
Other transportation equipment................................	373–75,379	472	18	10	8	8	4	5	1
Aircraft and missiles......................	372,376	245	29	5	24	23	0	5	1
Professional and scientific instruments...............................	38	1,371	252	101	151	149	54	23	26
Scientific and mechanical measuring instruments.............	381–82	692	137	58	79	75	35	11	16
Optical, surgical, photographic, and other instruments.....................	384–87	679	115	43	72	74	19	12	10
Other manufacturing industries[4]..........	27,31,39	147,421	1,764	1,733	31	32	190	1,324	218
Nonmanufacturing		1,635,161	19,973	19,338	635	644	629	15,861	2,839
Transportation and utilities................	40–42,44–49	29,102	882	845	37	34	54	685	109
Communications...........................	48	3,514	87	71	16	14	2	59	12
Telephone communications..................	481	1,206	34	24	10	10	1	20	3
Other communications.............	482–484,489	2,308	53	47	6	4	1	39	9
Electric, gas, and sanitary services.....................	49	1,343	85	68	17	15	31	28	11
Other transportation and utilities..............................	40–42,44–47	24,245	710	706	4	5	21	598	86
Trade...	50–59	228,409	4,644	4,563	81	80	90	3,773	701
Finance, insurance, and real estate.....................................	60–65,67	36,459	956	931	25	29	21	808	98
Services...	701,72,73,75–81, 83,84,87,89	177,150	7,332	6,851	481	486	399	5,468	979
Business services........................	73	42,510	1,397	1,180	217	225	159	752	261
Computer and data processing services.............	737	8,907	675	473	202	211	138	191	135
Other business services..........	731–736,738	33,603	722	707	15	14	21	561	126

See explanatory information and SOURCE at end of table.

Table B-1. Number of companies in the target population and selected for the sample, by industry: 1998

Industry	SIC code	Companies in target population	1998 survey Companies selected for 1998 sample	Noncertainties[1]	Certainties[2]	Companies with reported or imputed R&D expenditures for 1998 Greater than or equal to $5 million	Less than $5 million	Companies that reported no R&D expenditures for 1998	Other companies[3]
Health services............................	80	39,597	2,517	2,514	3	6	25	2,185	301
Offices and clinics of medical doctors, hospitals, medical and dental labs...................	801,806,807	19,828	416	415	1	2	11	363	40
Other health services..............	802–805,808–809	19,769	2,101	2,099	2	4	14	1,822	261
Engineering and management services.............	87	23,997	2,102	1,851	251	245	189	1,442	226
Engineering, architectural, and surveying.....................	871	9,069	821	771	50	56	117	579	69
Research, development, and testing..........................	873	2,864	268	73	195	176	34	33	25
Other engineering and management services........	872,874	12,064	1,013	1,007	6	13	38	830	132
Other services.............................	701,72,75–79,81, 83,84,89	71,046	1,316	1,306	10	10	26	1,089	191
Other nonmanufacturing industries[4]....	07–12,14,15, 161–162,17	1,164,041	6,159	6,148	11	14	65	5,127	953

[1] Noncertainties are companies whose probability of selection is less than one.

[2] Certainties are companies whose probability of selection is one. This includes companies whose 1997 R&D expenditures were equal to or greater than $5 million.

[3] Includes companies that reported they were out of scope, out of business, or had merged with another company. Also includes companies that did not respond to the survey or that did not indicate any information about R&D performance on a returned questionnaire.

[4] Beginning in 1996 manufacturing companies with fewer than 50 employees and nonmanufacturing companies with fewer than 15 employees were sampled separately without regard to industry classification to minimize year-to-year variation in survey estimates. Estimates for manufacturing companies in this group are combined with those for companies in "Other manufacturing industries." Estimates for nonmanufacturing companies in this group are combined with those for companies in "Other nonmanufacturing industries." As a result, statistics for "Other manufacturing industries" and for "Other nonmanufacturing industries" after 1995 are not comparable with statistics for prior years.

SOURCE: National Science Foundation/Division of Science Resources Studies, Survey of Industrial Research and Development: 1998

Table B-2. Relative standard error for selected estimates, by industry and by size of company: 1998

Industry and size of company	SIC code	Number of R&D-performing companies	Domestic net sales of R&D performers	Domestic employment of R&D performers	Number of FTE scientists and engineers	Total R&D	Company and other funds for R&D	Company-financed R&D performed outside of U.S.	Company-financed R&D contracted to outside organizations	Federal funds for R&D	Total funds for basic research	Total funds for applied research	Total funds for development
								[Percent]					
Distribution by industry:													
All industries..................................		3,326	4.7	2.2	1.6	1.7	1.8	1.1	4.6	3.3	6.1	3.9	2.1
Manufacturing............................		2,054	6.3	1.9	1.4	1.5	1.6	0.3	1.7	1.1	3.1	4.4	1.7
Food, kindred, and tobacco products	20,21	117	2.5	6.5	3.0	1.6	1.6	0.9	1.4	0.0	13.9	2.2	1.7
Textiles and apparel..............	22,23	67	5.6	7.0	4.1	6.1	6.1	NA	43.6	NA	19.7	45.4	2.1
Lumber, wood products, and furniture....................	24,25	73	3.5	4.4	4.8	4.0	3.6	NA	NA	31.6	10.0	5.2	3.2
Paper and allied products.....	26	48	9.6	8.9	17.1	7.7	7.9	0.7	79.9	NA	56.8	17.4	6.3
Chemicals and allied products.................	28	182	3.5	3.8	5.4	7.5	7.1	0.2	0.6	25.1	1.8	13.6	8.3
Industrial chemicals.........	281–82,286	58	8.9	9.4	18.1	23.5	23.3	0.0	0.0	27.0	7.6	33.8	27.8
Drugs and medicines.......	283	56	1.2	3.0	1.4	0.4	0.4	0.3	0.4	0.0	NA	0.4	0.4
Other chemicals..............	284–85, 287–89	68	2.8	4.8	3.0	2.0	2.1	0.4	4.8	NA	5.3	3.5	2.2
Petroleum refining and extraction..................	13,29	22	4.4	14.8	5.5	1.9	1.9	0.0	16.0	20.6	2.2	3.9	2.6
Rubber products...................	30	139	5.9	6.3	6.2	3.2	3.6	0.3	5.5	NA	8.9	3.8	5.2
Stone, clay, and glass products.................	32	32	20.7	20.2	3.4	1.1	1.1	0.0	6.3	NA	3.6	3.0	0.9
Primary metals.....................	33	72	4.6	5.1	5.5	4.7	6.2	36.8	87.6	NA	1.2	4.2	7.8
Ferrous metals and products..............	331–32, 3398–99	41	3.9	6.8	8.3	6.7	10.3	72.1	89.0	NA	17.0	4.7	9.4
Nonferrous metals and products..............	333–36	31	10.9	7.6	3.7	4.6	4.7	NA	0.0	NA	0.7	9.6	10.2

See explanatory information and SOURCE at end of table.

Table B-2. Relative standard error for selected estimates, by industry and by size of company: 1998

Industry and size of company	SIC code	Number of R&D-performing companies	Domestic net sales of R&D performers	Domestic employment of R&D performers	Number of FTE scientists and engineers	Total R&D	Company and other funds for R&D	Company-financed R&D performed outside of U.S.	Company-financed R&D contracted to outside organizations	Federal funds for R&D	Total funds for basic research	Total funds for applied research	Total funds for development
								[Percent]					
Distribution by industry:													
Fabricated metal products....	34	208	3.2	3.4	9.9	2.8	2.9	0.3	20.2	4.6	8.1	14.6	3.4
Machinery...........................	35	323	2.3	3.0	2.3	1.3	1.2	2.6	3.6	7.5	7.0	2.4	2.3
Office, computing, and accounting machines..	357	66	1.7	2.0	1.9	1.3	1.2	2.5	3.8	14.3	7.4	0.2	3.5
Other machinery, except electrical.........	351–56, 358–59	257	3.3	3.8	4.1	2.5	2.5	4.2	4.9	8.7	9.7	8.5	3.1
Electrical equipment............	36	279	2.3	2.2	1.5	1.6	1.3	1.0	5.2	8.0	16.4	5.3	2.1
Radio and TV receiving equipment....	365	14	2.2	2.5	0.7	0.9	0.9	NA	NA	0.0	0.0	4.7	1.1
Communication equipment..................	366	60	7.8	1.2	0.7	1.1	1.2	0.0	NA	NA	NA	15.2	NA
Electronic components.....	367	121	3.4	6.1	3.4	2.7	2.7	0.2	26.1	12.5	33.3	6.9	2.2
Other electrical equipment..................	361–64,369	84	1.8	2.6	6.3	5.9	3.7	3.9	0.2	23.8	4.1	0.5	8.0
Transportation equipment.....	37	67	25.9	7.7	2.0	1.0	1.5	NA	0.4	0.0	1.8	0.7	1.4
Motor vehicles and motor vehicles equipment..................	371	32	33.3	12.7	4.2	1.9	2.0	NA	0.4	NA	10.5	1.0	3.2
Other transportation equipment..................	373–75,379	12	7.2	12.8	12.1	10.3	17.7	NA	NA	NA	16.0	10.9	19.8
Aircraft and missiles........	372,376	23	0.0	0.0	0.0	0.0	0.0	NA	NA	0.0	NA	0.0	0.0
Professional and scientific instruments......................	38	203	1.6	2.1	2.1	1.5	2.3	0.5	10.7	NA	2.7	6.0	2.8
Scientific and mechanical measuring instruments..............	381–82	110	2.5	2.8	2.9	1.2	2.9	2.5	16.9	NA	9.2	16.6	2.9
Optical, surgical, photographic, and other instruments.......	384–87	93	2.1	3.1	2.9	3.1	3.2	0.2	13.4	0.0	2.4	4.9	4.1

See explanatory information and SOURCE at end of table.

Table B-2. Relative standard error for selected estimates, by industry and by size of company: 1998

Industry and size of company	SIC code	Number of R&D-performing companies	Domestic net sales of R&D performers	Domestic employment of R&D performers	Number of FTE scientists and engineers	Total R&D	Company and other funds for R&D	Company-financed R&D performed outside of U.S.	Company-financed R&D contracted to outside organizations	Federal funds for R&D	Total funds for basic research	Total funds for applied research	Total funds for development
								[Percent]					
Distribution by industry:													
Other manufacturing industries[1]........................	27,31,39	222	9.8	6.0	16.2	13.9	14.0	8.3	51.7	78.6	18.1	24.7	18.7
Nonmanufacturing		1,272	5.7	5.2	4.0	4.5	4.7	5.3	14.5	12.8	15.5	8.4	5.5
Transportation and utilities....	40–42, 44–49	88	4.0	2.6	1.9	1.1	1.4	NA	3.4	NA	24.1	4.4	0.6
Communications.............	48	16	0.3	0.3	1.8	1.2	1.4	NA	NA	NA	29.6	5.0	NA
Telephone communications....	481	11	0.0	0.1	2.7	1.0	1.1	NA	NA	NA	NA	5.7	NA
Other communications....	482–484, 489	5	6.5	3.6	1.0	5.4	17.0	0.0	0.0	NA	81.2	NA	NA
Electric, gas, and sanitary services........	49	46	10.2	11.8	10.1	6.0	6.9	NA	7.2	NA	8.7	5.4	8.9
Other transportation and utilities................	40–42, 44–47	26	1.7	1.0	12.7	4.3	4.3	NA	11.0	NA	54.1	7.4	4.0
Trade..................................	50–59	170	10.5	17.1	5.1	5.7	5.7	2.0	1.6	0.0	14.2	4.2	6.9
Finance, insurance, and real estate.......................	60–65,67	50	19.8	14.1	8.7	7.4	7.4	NA	49.0	NA	78.9	12.7	3.8
Services..............................	701,72,73, 75–81,83, 84,87,89	885	3.0	3.3	4.6	6.2	6.8	9.1	24.9	14.5	21.2	11.3	9.0
Business services...........	73	384	3.1	3.6	4.0	3.4	3.4	3.5	24.2	23.5	18.1	7.4	4.2
Computer and data processing services................	737	349	3.0	4.6	3.9	3.4	3.4	3.5	24.3	24.0	18.3	7.6	4.3
Other business services................	731–736, 738	35	10.3	5.7	35.4	21.9	22.6	0.2	16.0	0.0	72.2	0.1	24.0

See explanatory information and SOURCE at end of table.

Table B-2. Relative standard error for selected estimates, by industry and by size of company: 1998

Industry and size of company	SIC code	Number of R&D-performing companies	Domestic net sales of R&D performers	Domestic employment of R&D performers	Number of FTE scientists and engineers	Total R&D	Company and other funds for R&D	Company-financed R&D performed outside of U.S.	Company-financed R&D contracted to outside organizations	Federal funds for R&D	Total funds for basic research	Total funds for applied research	Total funds for development
								[Percent]					
Distribution by industry:													
Health services...............	80	31	5.8	9.1	21.7	42.5	43.7	NA	0.1	66.2	95.6	20.9	35.8
Offices and clinics of medical doctors, hospitals, medical and dental labs......	801,806, 807	13	6.4	11.3	23.7	46.7	47.6	NA	NA	90.3	98.8	48.1	61.2
Other health services.......	802–805, 808–809	18	13.7	12.3	49.4	27.1	26.8	NA	0.9	87.7	78.5	20.8	40.8
Engineering and management services.	87	434	8.4	6.5	10.3	13.0	18.4	52.5	40.9	7.8	8.7	17.1	22.6
Engineering, architectural, and surveying...............	871	173	14.1	9.2	6.7	5.1	12.2	0.0	0.9	1.2	8.5	9.1	9.3
Research, development, and testing.............	873	210	8.4	9.4	16.7	16.7	22.1	54.9	45.4	11.5	11.9	21.9	28.8
Other engineering and management services.................	872,874	51	14.1	14.8	10.7	15.9	14.0	0.0	58.9	86.0	7.6	23.6	26.3
Other services................	701,72, 75–79,81, 83,84,89	36	8.8	14.8	65.8	64.6	17.9	NA	NA	95.9	70.0	26.7	73.7
Other nonmanufacturing industries[1]........................	07–12, 14,15, 161–162,17	79	7.4	11.1	21.7	25.3	27.7	56.7	94.0	52.9	45.1	46.9	28.2

See explanatory information and SOURCE at end of table.

Table B-2. Relative standard error for selected estimates, by industry and by size of company: 1998

Industry and size of company	SIC code	Number of R&D-performing companies	Domestic net sales of R&D performers	Domestic employment of R&D performers	Number of FTE scientists and engineers	Total R&D	Company and other funds for R&D	Company-financed R&D performed outside of U.S.	Company-financed R&D contracted to outside organizations	Federal funds for R&D	Total funds for basic research	Total funds for applied research	Total funds for development
								[Percent]					
Distribution by size of company: [Number of employees]													
Total..............................		3,326	4.7	2.2	1.6	1.7	1.8	1.1	4.6	3.3	6.1	3.9	2.1
Fewer than 500.........................		1,541	6.1	4.8	6.9	9.2	9.6	25.8	30.1	23.0	18.7	15.9	10.9
500 to 999.................................		430	14.2	12.0	5.5	4.2	4.5	16.9	12.0	0.6	8.0	5.8	5.5
1,000 to 4,999..........................		803	10.5	7.7	2.2	1.2	1.2	0.8	5.9	0.0	6.2	1.1	1.6
5,000 to 9,999..........................		260	26.6	4.3	0.8	1.1	1.2	0.1	1.4	0.0	0.0	0.6	1.7
10,000 to 24,999.......................		177	4.7	2.1	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.1
25,000 or more..........................		115	1.2	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

[1] Manufacturing companies with fewer than 50 employees and nonmanufacturing companies with fewer than 15 employees were sampled separately without regard to industry classification to minimize year-to-year variation in survey estimates. Estimates for manufacturing companies in this group are combined with those for companies in "Other manufacturing industries." Estimates for nonmanufacturing companies in this group are combined with those for companies in "Other nonmanufacturing industries."

KEY: NA = Not available.

NOTE: The percentage (or relative) standard errors in this table may be converted to standard errors of estimate by multiplying the percentages shown by the associated estimates. For example, the relative standard error of estimate for company-funded R&D performance by the stone, clay, and glass products industry (SIC 32) is shown as 1.1 percent, and the associated company-funded R&D estimate for this industry is shown as $592 million in table A-7. The standard error of estimate is 0.011 times 592 or $6.5 million.

SOURCE: National Science Foundation/Division of Science Resources Studies, Survey of Industrial Research and Development: 1998

Table B-3. Unit response rates—percentage of companies that responded to the survey, by industry and survey form: 1998

Industry and form received	SIC code	Number of companies that received questionnaire[1]	Response rate[2]
			[Percent]
All industries..		24,729	86.6
Manufacturing..		4,817	85.7
Food, kindred, and tobacco products……………..........	20,21	233	86.3
Textiles and apparel..	22,23	185	82.7
Lumber, wood products, and furniture...........................	24,25	225	86.2
Paper and allied products...	26	73	91.8
Chemicals and allied products......................................	28	208	86.6
Industrial chemicals...	281–82,286	62	90.3
Drugs and medicines...	283	60	81.7
Other chemicals...	284–85,287–89	86	87.4
Petroleum refining and extraction.................................	13,29	62	87.3
Rubber products...	30	239	86.6
Stone, clay, and glass products....................................	32	60	86.7
Primary metals...	33	125	89.6
Ferrous metals and products....................................	331–32,3398–99	72	90.3
Nonferrous metals and products...............................	333–36	53	88.7
Fabricated metal products...	34	454	85.0
Machinery...	35	489	82.0
Office, computing, and accounting machines.............	357	82	82.9
Other machinery, except electrical............................	351–56,358–59	407	81.9
Electrical equipment...	36	365	76.4
Radio and TV receiving equipment...........................	365	16	93.8
Communication equipment.......................................	366	68	70.6
Electronic components...	367	156	76.3
Other electrical equipment.......................................	361–64,369	125	77.6
Transportation equipment...	37	89	89.9
Motor vehicles and motor vehicles equipment...........	371	42	92.9
Other transportation equipment................................	373–75,379	18	83.3
Aircraft and missiles..	372,376	29	89.7
Professional and scientific instruments.........................	38	246	85.4
Scientific and mechanical measuring instruments..	381–82	133	85.7
Optical, surgical, photographic, and other instruments..	384–87	113	85.0
Other manufacturing industries[3]…………………........	27,31,39	1,764	88.6
Nonmanufacturing..		19,912	86.8
Transportation and utilities..	40–42,44–49	879	88.4
Communications...	48	87	87.4
Telephone communications...................................	481	34	91.2
Other communications..	482–484,489	53	84.9
Electric, gas, and sanitary services............................	49	84	86.9
Other transportation and utilities...............................	40–42,44–47	708	88.7

See explanatory information and SOURCE at end of table.

Table B-3. Unit response rates—percentage of companies that responded to the survey, by industry and survey form: 1998

Industry and form received	SIC code	Number of companies that received questionnaire[1]	Response rate[2]
			[Percent]
Trade...	50–59	4,639	86.1
Finance, insurance, and real estate...............................	60–65,67	953	90.9
Services...	701,72,73,75–81, 83,84,87,89	7,323	87.0
Business services......................................	73	1,395	80.4
Computer and data processing services..............	737	673	77.9
Other business services................................	731–736,738	722	82.7
Health services...	80	2,515	89.0
Offices and clinics of medical doctors, hospitals, medical and dental labs..................	801,806,807	415	91.4
Other health services....................................	802–805,808–809	2,100	88.5
Engineering and management services.....................	87	2,097	88.8
Engineering, architectural, and surveying.............	871	820	90.6
Research, development, and testing....................	873	266	85.3
Other engineering and management services...	872,874	1,011	88.2
Other services...	701,72,75–79,81, 83,84,89	1,316	87.1
Other nonmanufacturing industries[3]...............................	07–12,14,15, 161–162,17	6,118	86.2
All companies receiving Form RD-1			
All industries..……………………………………..............		1,621	83.0
Manufacturing...........……………………….................		991	84.9
Food, kindred, and tobacco products	20,21	41	82.9
Textiles and apparel...	22,23	14	71.4
Lumber, wood products, and furniture............................	24,25	14	92.9
Paper and allied products...	26	27	88.9
Chemicals and allied products.......................................	28	147	87.2
Industrial chemicals...................................	281–82,286	54	90.9
Drugs and medicines..................................	283	55	80.0
Other chemicals..	284–85,287–89	38	92.1
Petroleum refining and extraction...................................	13,29	16	94.1
Rubber products..	30	42	90.5
Stone, clay, and glass products.....................................	32	15	100.0
Primary metals..	33	26	96.2
Ferrous metals and products.....................................	331–32,3398–99	14	100.0
Nonferrous metals and products................................	333–36	12	91.7
Fabricated metal products...	34	35	91.4
Machinery..	35	167	82.6
Office, computing, and accounting machines.............	357	51	86.3
Other machinery, except electrical............................	351–56,358–59	116	81.0

See explanatory information and SOURCE at end of table.

Table B-3. Unit response rates—percentage of companies that responded to the survey, by industry and survey form: 1998			
Industry and form received	SIC code	Number of companies that received questionnaire[1]	Response rate[2]
			[Percent]
All companies receiving Form RD-1			
Electrical equipment...	36	210	79.1
Radio and TV receiving equipment............................	365	4	100.0
Communication equipment..	366	60	76.7
Electronic components...	367	94	77.7
Other electrical equipment.......................................	361–64,369	52	82.7
Transportation equipment...	37	57	89.5
Motor vehicles and motor vehicles equipment............	371	25	96.0
Other transportation equipment................................	373–75,379	8	75.0
Aircraft and missiles..	372,376	24	87.5
Professional and scientific instruments........................	38	149	85.2
Scientific and mechanical measuring instruments...	381–82	77	87.0
Optical, surgical, photographic, and other instruments...	384–87	72	83.3
Other manufacturing industries[1]………………...........	27,31,39	31	80.7
Nonmanufacturing		630	80.0
Transportation and utilities..	40–42,44–49	36	86.1
Communications...	48	16	87.5
Telephone communications.................................	481	10	100.0
Other communications..	482–484,489	6	66.7
Electric, gas, and sanitary services...........................	49	16	81.3
Other transportation and utilities..............................	40–42,44–47	4	100.0
Trade...	50–59	81	79.0
Finance, insurance, and real estate...............................	60–65,67	24	79.2
Services...	701,72,73,75–81, 83,84,87,89	478	79.7
Business services..	73	216	75.9
Computer and data processing services...............	737	201	77.1
Other business services......................................	731–736,738	15	60.0
Health services..	80	3	100.0
Offices and clinics of medical doctors, hospitals, medical and dental labs...................	801,806,807	1	100.0
Other health services...	802–805,808–809	2	100.0
Engineering and management services......................	87	249	82.7
Engineering, architectural, and surveying.............	871	50	72.0
Research, development, and testing.....................	873	193	85.0
Other engineering and management services..	872,874	6	100.0
Other services..	701,72,75–79,81, 83,84,89	10	80.0
Other nonmanufacturing industries[3]..............................	07–12,14,15, 161–162,17	11	81.8

See explanatory information and SOURCE at end of table.

Table B-3. Unit response rates—percentage of companies that responded to the survey, by industry and survey form: 1998

Industry and form received	SIC code	Number of companies that received questionnaire[1]	Response rate[2]
			[Percent]
All companies receiving Form RD-1A			
All industries..		23,108	86.8
Manufacturing................……………......................		3,826	85.9
Food, kindred, and tobacco products.............................	20,21	192	87.0
Textiles and apparel..	22,23	171	83.6
Lumber, wood products, and furniture............................	24,25	211	85.8
Paper and allied products..	26	46	93.5
Chemicals and allied products.......................................	28	61	85.3
Industrial chemicals...	281–82,286	8	85.7
Drugs and medicines..	283	5	100.0
Other chemicals...	284–85,287–89	48	83.7
Petroleum refining and extraction..................................	13,29	46	84.8
Rubber products..	30	197	85.8
Stone, clay, and glass products.....................................	32	45	82.2
Primary metals..	33	99	87.9
Ferrous metals and products.....................................	331–32,3398–99	58	87.9
Nonferrous metals and products................................	333–36	41	87.8
Fabricated metal products...	34	419	84.5
Machinery...	35	322	81.7
Office, computing, and accounting machines.............	357	31	77.4
Other machinery, except electrical.............................	351–56,358–59	291	82.2
Electrical equipment..	36	155	72.9
Radio and TV receiving equipment.............................	365	12	91.7
Communication equipment..	366	8	25.0
Electronic components..	367	62	74.2
Other electrical equipment..	361–64,369	73	74.0
Transportation equipment..	37	32	90.6
Motor vehicles and motor vehicles equipment............	371	17	88.2
Other transportation equipment.................................	373–75,379	10	90.0
Aircraft and missiles...	372,376	5	100.0
Professional and scientific instruments...........................	38	97	85.6
Scientific and mechanical measuring instruments..	381–82	56	83.9
Optical, surgical, photographic, and other instruments..	384–87	41	87.8
Other manufacturing industries[3]..................…………...........	27,31,39	1,733	88.8

See explanatory information and SOURCE at end of table.

Table B-3. Unit response rates—percentage of companies that responded to the survey, by industry and survey form: 1998			
Industry and form received	SIC code	Number of companies that received questionnaire[1]	Response rate[2]
			[Percent]
All companies receiving Form RD-1A			
Nonmanufacturing ....………………….…....		19,282	87.0
Transportation and utilities.............................	40–42,44–49	843	88.5
Communications...	48	71	87.3
Telephone communications................................	481	24	87.5
Other communications..................................	482–484,489	47	87.2
Electric, gas, and sanitary services...........................	49	68	88.2
Other transportation and utilities...............................	40–42,44–47	704	88.7
Trade..	50–59	4,558	86.2
Finance, insurance, and real estate...............................	60–65,67	929	91.2
Services..	701,72,73,75–81, 83,84,87,89	6,845	87.5
Business services...	73	1,179	81.3
Computer and data processing services...............	737	472	78.3
Other business services....................................	731–736,738	707	83.2
Health services...	80	2,512	88.9
Offices and clinics of medical doctors, hospitals, medical and dental labs...................	801,806,807	414	91.4
Other health services...	802–805,808–809	2,098	88.5
Engineering and management services.....................	87	1,848	89.6
Engineering, architectural, and surveying.............	871	770	91.8
Research, development, and testing.....................	873	73	86.3
Other engineering and management services...	872,874	1,005	88.2
Other services...	701,72,75–79,81, 83,84,89	1,306	87.1
Other nonmanufacturing industries[3]...............................	07–12,14,15, 161–162,17	6,107	86.3

[1] The total number of companies is generally less than the number of "compaines selected for the sample" in table B-1 because some companies selected for the survey went out of business or were merged with other companies during the time between sampling and mailout of the questionnaires.

[2] The calculation of this response rate, essentially a contact rate, was based on all companies that responded to the survey, including those that reported they were out of scope, out of business, or had merged with another company. Mathematically, the rate was calculated by dividing the number of companies that received a questionnaire (indicated in the previous column) into the number of companies that returned a response or questionnaire regardless of the data or information supplied in the response or on the questionnaire.

[3] Manufacturing companies with fewer than 50 employees and nonmanufacturing companies with fewer than 15 employees were sampled separately without regard to industry classification to minimize year-to-year variation in survey estimates. Estimates for manufacturing companies in this group are combined with those for companies in "Other manufacturing industries." Estimates for nonmanufacturing companies in this group are combined with those for companies in "Other nonmanufacturing industries."

SOURCE: National Science Foundation/Division of Science Resources Studies, Survey of Industrial Research and Development: 1998

Table B-4. Imputation rates for survey items, by industry: 1998

Industry	SIC code	Net Sales	Total employ-ment	R&D scientists/ engineers	Total R&D			R&D by cost				Company-funded	
					Total	Company	Federal	Wages	Materials	Depre-ciation	Other costs	R&D outside company	Foreign R&D
							[Percent]						
All industries......................................		6.5	8.8	35.2	6.4	5.6	16.3	56.0	54.6	7.1	54.1	3.2	1.9
Manufacturing..............................		6.4	7.8	41.0	4.7	5.1	3.4	58.9	54.6	7.0	55.5	2.6	2.1
Food, kindred, and tobacco products	20,21	7.5	13.3	36.9	8.5	8.6	0.0	49.1	49.3	0.0	49.4	0.3	0.0
Textiles and apparel................	22,23	9.3	10.0	48.7	23.1	23.1	0.0	89.9	91.9	NA	83.9	0.0	NA
Lumber, wood products, and furniture.......................	24,25	3.7	2.5	40.5	5.4	5.6	0.0	37.8	54.8	0.0	36.4	NA	2.0
Paper and allied products.............................	26	12.9	15.6	55.3	42.1	40.6	99.6	83.6	84.9	NA	86.8	0.0	0.0
Chemicals and allied products.............................	28	5.2	6.1	24.9	4.7	3.7	64.7	54.4	52.5	0.0	57.1	1.7	1.2
Industrial chemicals...........	281–82,286	6.5	8.2	16.7	9.4	5.2	69.4	70.5	75.9	NA	71.3	10.8	3.9
Drugs and medicines.........	283	4.6	4.9	26.5	2.6	2.6	28.5	50.2	44.4	0.0	55.3	1.7	0.5
Other chemicals................	284–85, 287–89	4.1	4.9	34.7	2.2	5.9	0.0	34.4	32.2	NA	38.1	0.1	0.0
Petroleum refining and extraction...........................	13,29	5.8	20.3	26.8	2.8	2.8	2.7	63.3	52.4	21.6	79.3	9.7	4.3
Rubber products.....................	30	4.4	8.0	27.2	3.2	3.6	0.0	70.0	60.3	NA	81.7	0.0	0.0
Stone, clay, and glass products...................	32	0.0	0.0	47.0	NA	0.0	NA	56.6	27.7	NA	38.3	NA	NA
Primary metals.......................	33	1.9	5.0	47.3	31.6	17.5	NA	39.5	45.5	10.3	72.9	0.0	2.5
Ferrous metals and products.......................	331–32, 3398–99	0.0	0.0	53.1	45.9	27.6	NA	57.1	49.6	45.4	75.5	0.0	0.0
Nonferrous metals and products................	333–36	5.6	13.1	37.0	4.4	4.6	NA	16.6	39.1	NA	58.1	0.0	5.1

See SOURCE at end of table.

Table B-4. Imputation rates for survey items, by industry: 1998

Industry	SIC code	Net Sales	Total employment	R&D scientists/ engineers	Total R&D			R&D by cost				Company-funded	
					Total	Company	Federal	Wages	Materials	Depreciation	Other costs	R&D outside company	Foreign R&D
								[Percent]					
Fabricated metal products.......	34	1.3	3.6	17.3	1.6	2.1	0.0	49.7	54.0	0.0	52.9	0.0	0.0
Machinery................................	35	10.4	8.1	24.0	8.5	8.5	6.3	45.6	37.8	3.6	24.6	15.7	5.7
Office, computing, and accounting machines.....	357	16.8	11.6	10.9	8.5	8.5	0.0	49.2	40.3	0.0	20.6	49.6	5.6
Other machinery, except electrical............	351–56, 358–59	7.2	7.2	35.9	8.6	8.6	7.9	41.0	36.2	8.6	38.3	1.3	5.8
Electrical equipment................	36	13.0	14.3	52.1	5.4	5.7	1.0	58.1	65.3	2.9	61.8	0.2	2.7
Radio and TV receiving equipment.....................	365	0.0	28.8	0.0	0.0	0.0	0.0	24.9	55.4	32.3	41.9	NA	NA
Communication equipment.....................	366	12.1	9.4	61.4	5.0	5.4	0.4	54.8	67.7	NA	55.1	NA	5.3
Electronic components.......	367	25.3	24.2	53.4	6.8	6.7	13.9	68.2	69.8	2.9	72.6	0.2	0.6
Other electrical equipment.....................	361–64,369	4.9	10.0	20.8	3.7	4.1	0.1	46.2	45.9	3.4	51.2	0.6	1.5
Transportation equipment.......	37	2.4	0.6	52.0	0.2	0.6	0.1	53.2	46.0	0.0	54.5	NA	NA
Motor vehicles and motor vehicles equipment.......	371	0.0	0.1	38.7	NA	0.3	NA	39.6	37.4	NA	43.3	NA	NA
Other transportation equipment.....................	373–75,379	3.5	4.2	50.6	2.8	4.8	0.0	63.6	37.2	NA	32.4	100.0	NA
Aircraft and missiles...........	372,376	11.4	1.1	64.6	0.3	1.2	0.1	66.2	57.1	0.0	62.9	NA	NA
Professional and scientific instruments..........	38	4.2	5.2	58.3	2.9	4.1	0.2	82.0	80.1	2.7	79.7	0.0	0.4
Scientific and mechanical measuring instruments...................	381–82	3.7	4.6	64.0	1.8	4.2	NA	85.6	82.5	6.9	85.7	0.0	1.5
Optical, surgical, photographic, and other instruments..........	384–87	4.7	5.8	50.3	4.4	4.0	14.3	76.5	77.1	0.0	71.1	0.0	0.2
Other manufacturing industries[1]..........................	27,31,39	3.2	2.8	11.7	1.6	1.7	0.0	54.3	42.9	89.6	47.3	0.0	0.0

See SOURCE at end of table.

Table B-4. Imputation rates for survey items, by industry: 1998

Industry	SIC code	Net Sales	Total employment	R&D scientists/ engineers	Total R&D			R&D by cost				Company-funded	
					Total	Company	Federal	Wages	Materials	Depreciation	Other costs	R&D outside company	Foreign R&D
								[Percent]					
Nonmanufacturing........................		6.6	10.6	24.0	10.5	6.8	51.9	47.4	54.5	NA	48.9	4.8	1.5
Transportation and utilities......	40–42, 44–49	5.4	10.6	60.3	16.5	20.1	NA	64.3	66.9	NA	67.8	4.7	NA
Communications...............	48	0.9	6.9	67.0	16.6	20.9	NA	60.7	67.0	NA	68.2	NA	NA
Telephone communications.......	481	0.9	7.3	55.6	19.5	22.2	NA	55.0	63.1	NA	62.4	NA	NA
Other communications..	482–484, 489	0.0	0.0	88.1	NA	0.0	NA	96.8	96.6	NA	98.3	0.0	0.0
Electric, gas, and sanitary services...........	49	8.0	8.5	21.3	9.2	10.4	NA	52.1	42.1	NA	32.4	10.0	NA
Other transportation and utilities....................	40–42, 44–47	11.0	16.1	16.5	21.7	21.7	NA	96.8	100.0	NA	99.6	NA	NA
Trade......................................	50–59	2.7	2.7	14.1	4.5	4.2	61.4	32.8	40.4	0.0	40.9	3.8	0.7
Finance, insurance, and real estate..........................	60–65,67	7.3	14.4	27.0	5.1	5.1	0.0	59.4	94.8	0.0	52.9	0.0	NA
Services.................................	701,72,73, 75–81, 83,84,87,89	11.2	16.6	22.4	13.4	7.3	43.6	52.4	59.5	0.0	48.9	3.3	2.0
Business services..............	73	12.6	19.6	23.1	8.6	8.5	13.3	49.9	62.7	0.0	51.1	3.3	1.6
Computer and data processing services...................	737	10.4	11.0	23.1	7.8	7.7	12.4	49.4	62.9	NA	50.5	3.3	1.5
Other business services...................	731–736, 738	21.9	35.7	24.0	36.8	36.4	48.9	75.3	52.3	NA	73.0	0.0	28.3

See SOURCE at end of table.

Table B-4. Imputation rates for survey items, by industry: 1998

Industry	SIC code	Net Sales	Total employ-ment	R&D scientists/ engineers	Total R&D			R&D by cost				Company-funded	
					Total	Company	Federal	Wages	Materials	Depre-ciation	Other costs	R&D outside company	Foreign R&D
								[Percent]					
Health services..................	80	10.5	0.9	0.8	0.4	0.4	0.0	96.1	97.9	0.0	0.0	NA	NA
Offices and clinics of medical doctors, hospitals, medical and dental labs........	801,806,807	11.9	1.2	1.1	0.4	0.4	0.0	100.0	100.0	0.0	0.0	NA	NA
Other health services....	802–805, 808–809	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA
Engineering and management services...	87	8.8	13.3	23.9	21.8	6.4	56.4	53.7	53.6	0.0	48.5	4.3	3.3
Engineering, architectural, and surveying.................	871	6.8	12.6	38.8	26.8	13.5	36.2	63.3	68.0	0.0	57.7	12.8	10.6
Research, development, and testing.....................	873	18.0	22.4	13.3	22.2	6.0	68.3	49.4	50.3	0.0	45.7	4.6	2.9
Other engineering and management services..................	872,874	0.3	0.0	43.6	0.0	0.0	0.0	81.0	100.0	0.0	97.1	0.0	0.0
Other services...................	701,72, 75–79,81, 83,84,89	10.6	14.8	11.3	2.2	6.2	0.0	42.9	33.4	0.0	48.1	0.2	9.7
Other nonmanufacturing industries[1]..........................	07–12, 14,15, 161–162,17	9.4	5.0	30.1	1.1	1.2	0.0	25.0	36.8	0.0	27.9	0.0	4.5

[1] Manufacturing companies with fewer than 50 employees and nonmanufacturing companies with fewer than 15 employees were sampled separately without regard to industry classification to minimize year-to-year variation in survey estimates. Estimates for manufacturing companies in this group are combined with those for companies in "Other manufacturing industries." Estimates for nonmanufacturing companies in this group are combined with those for companies in "Other nonmanufacturing industries."

KEY: NA = Not available.

SOURCE: National Science Foundation/Division of Science Resources Studies, Survey of Industrial Research and Development: 1998

Table B-5. Reported items—percentage of R&D-performing companies that reported non-zero data for major survey items: 1998

Data item	Form RD-1[1,2]	Form RD-1A[1,2]
Sales[3]..	98.6	98.9
Total employment[3]..	98.1	99.0
Scientist and engineers..	76.3	81.7
Federal R&D[3,4]...	100.0	100.0
Department of Defense..	6.8	NA
NASA..	2.3	NA
Department of Energy...	2.1	NA
Other Federal agencies...	6.3	NA
Company R&D[3,4]...	100.0	100.0
Foreign R&D...	33.7	6.3
Contracted-out R&D...	20.3	12.0
Total R&D[3]...	100.0	100.0
Wages and salaries...	66.7	NA
Materials and supplies..	60.7	NA
R&D depreciation..	29.1	NA
Other costs..	64.0	NA
Energy R&D...	4.3	NA

[1] Percentages are based on reported data for companies that reported total R&D expenditures. Imputed data are not included. Companies that reported they were out of scope, out of business, merged with another company, or had no R&D expenditures for 1998 were excluded from the calculations.

[2] See technical notes for descriptions of the survey questionnaire forms.

[3] Response to four data items on the questionnaires, total R&D expenditures, Federally-funded R&D expenditures, net sales, and total employment, was mandatory. Response to all other items was voluntary.

[4] "Federal R&D" and "Company R&D" are considered together; companies that report "Total R&D" and either of these expenditures implicitly report both company and Federal R&D, since these two items sum to total R&D.

KEY: NA = not asked.

SOURCE: National Science Foundation/Division of Science Resources Studies, Survey of Industrial Research and Development: 1998

Table B-6. Funds for performance of industrial basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry, by size of company, and by source of funds: 1998

Industry and size of company	SIC code	Total			Basic research			Applied research		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[In millions of dollars]								
Distribution by industry:										
All industries...................…………..		169,180	24,164	145,016	10,612	1,357	9,255	23,439	1,971	21,468
Manufacturing……………………………..		120,401	18,189	102,211	(D)	(D)	5,930	(D)	(D)	15,901
Food, kindred, and tobacco products..................	20,21	1,711	0	1,711	84	0	84	520	0	520
Textiles and apparel..	22,23	(D)	(D)	543	38	(D)	(D)	66	0	66
Lumber, wood products, and furniture.................	24,25	374	14	359	44	0	44	(D)	(D)	33
Paper and allied products....................................	26	(D)	(D)	1,583	211	0	211	112	0	112
Chemicals and allied products.............................	28	21,764	(S) 483	21,282	(D)	(D)	2,628	5,053	148	4,905
Industrial chemicals.......................................	281–82,286	(D)	(D)	6,467	(D)	(D)	629	2,028	124	1,904
Drugs and medicines......................................	283	12,571	5	12,566	(D)	(D)	1,878	(D)	(D)	2,349
Other chemicals...	284–85,287–89	(D)	(D)	2,249	121	0	121	(D)	(D)	652
Petroleum refining and extraction........................	13,29	1,808	6	1,802	56	2	54	(D)	(D)	542
Rubber products..	30	(D)	(D)	1,607	129	0	129	(D)	(D)	197
Stone, clay, and glass products...........................	32	(D)	(D)	592	(D)	(D)	(D)	191	0	191
Primary metals..	33	(D)	(D)	720	(D)	(D)	(D)	(D)	(D)	179
Ferrous metals and products..........................	331–32,3398–99	(D)	(D)	405	(D)	(D)	5	(D)	(D)	116
Nonferrous metals and products....................	333–36	(D)	(D)	315	(D)	(D)	(D)	63	0	63
Fabricated metal products...................................	34	1,595	43	1,551	63	0	63	(D)	(D)	188
Machinery...	35	14,919	73	14,846	(D)	(D)	449	(D)	(D)	2,311
Office, computing, and accounting machines.	357	8,905	15	8,890	(D)	(D)	146	(D)	(D)	1,668
Other machinery, except electrical.................	351–56,358–59	6,014	58	5,956	(D)	(D)	303	(D)	(D)	643
Electrical equipment...	36	25,990	1,613	24,378	(D)	(D)	897	4,300	99	4,202
Radio and TV receiving equipment................	365	155	0	155	34	0	34	11	0	11
Communication equipment.............................	366	(D)	(D)	10,173	(D)	(D)	(D)	779	0	779
Electronic components...................................	367	(D)	(D)	9,776	(D)	(D)	(D)	(D)	(D)	2,781
Other electrical equipment.............................	361–64,369	4,811	538	4,273	(D)	(D)	272	(D)	(D)	631
Transportation equipment...................................	37	29,279	10,330	18,948	(D)	(D)	(D)	(D)	(D)	968
Motor vehicles and motor vehicles equipment	371	(D)	(D)	13,502	(D)	(D)	(D)	(D)	(D)	702
Other transportation equipment....................	373–75,379	(D)	(D)	339	(D)	0	(D)	(D)	(D)	44
Aircraft and missiles.......................................	372,376	14,449	9,341	5,108	(D)	(D)	148	(D)	(D)	223

See explanatory information and SOURCE at end of table.

Table B-6. Funds for performance of industrial basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry, by size of company, and by source of funds: 1998

Industry and size of company	SIC code	Total			Basic research			Applied research		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[In millions of dollars]								
Distribution by industry:										
Professional and scientific instruments...............	38	(D)	(D)	9,625	(D)	(D)	624	1,087	39	1,047
Scientific and mechanical measuring instruments.................................	381–82	(D)	(D)	3,614	130	0	130	317	(S) 16	301
Optical, surgical, photographic, and other instruments.................................	384–87	6,085	74	6,011	(D)	(D)	494	770	23	746
Other manufacturing industries[1].......................	27,31,39	2,795	131	2,664	(D)	(D)	187	549	109	440
Nonmanufacturing ……….……............................		48,780	5,975	42,805	(D)	(D)	3,325	(D)	(D)	5,567
Transportation and utilities.................................	40–42,44–49	(D)	(D)	2,219	(D)	(D)	(D)	(D)	(D)	347
Communications..	48	(D)	(D)	1,768	(D)	(D)	(D)	(D)	(D)	291
Telephone communications......................	481	(D)	(D)	1,665	(D)	(D)	(D)	(D)	(D)	(D)
Other communications.............................	482–484,489	(D)	(D)	103	22	(D)	(D)	(D)	(D)	(D)
Electric, gas, and sanitary services...............	49	(D)	(D)	182	12	0	12	40	0	40
Other transportation and utilities....................	40–42,44–47	(D)	(D)	269	(D)	(D)	(D)	16	0	16
Trade..	50–59	11,336	(S) 64	11,273	(D)	(D)	620	(D)	(D)	1,502
Finance, insurance, and real estate....................	60–65,67	(D)	(D)	1,623	(D)	(D)	133	32	0	32
Services..	701,72,73,75–81, 83,84,87,89	29,281	4,889	24,392	(D)	(D)	2,151	3,848	741	3,106
Business services..	73	15,222	540	14,682	(D)	(D)	(D)	1,252	159	1,092
Computer and data processing services...	737	(D)	(D)	14,297	(D)	(D)	(D)	1,224	159	1,065
Other business services............................	731–736,738	(D)	(D)	385	60	0	60	27	0	27
Health services...	80	1,207	33	1,173	535	11	524	(D)	(D)	78
Offices and clinics of medical doctors, hospitals, medical and dental labs.......	801,806,807	1,096	21	1,074	518	0	518	(D)	(D)	25
Other health services...............................	802–805,808–809	111	12	99	17	11	6	54	1	53
Engineering and management services.........	87	11,835	(S) 3,652	8,182	(D)	(D)	1,044	(D)	(D)	(D)
Engineering, architectural, and surveying..	871	2,025	1,190	835	(D)	(D)	45	(D)	(D)	(D)
Research, development, and testing.........	873	9,169	(S) 2,388	6,780	(D)	(D)	810	1,921	271	1,650
Other engineering and management services.........................	872,874	641	74	567	(D)	(D)	190	(D)	(D)	(D)

See explanatory information and SOURCE at end of table.

Table B-6. Funds for performance of industrial basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry, by size of company, and by source of funds: 1998

Industry and size of company	SIC code	Total			Basic research			Applied research		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[In millions of dollars]								
Distribution by industry:										
Other services..	701,72,75–79,81, 83,84,89	1,017	663	354	(D)	(D)	(D)	(D)	(D)	(D)
Other nonmanufacturing industries[1]..................……	07–12,14,15, 161–162,17	3,830	532	3,298	507	155	352	681	102	580
Distribution by size of company: [Number of employees]										
Total......…………………………..................		169,180	24,164	145,016	10,612	1,357	9,255	23,439	1,971	21,468
Fewer than 500.................…………….........		30,175	3,436	26,739	3,393	522	2,871	5,772	828	4,944
500 to 999..................…………………........		5,495	363	5,132	(D)	(D)	836	(D)	(D)	986
1,000 to 4,999...................……………........		21,525	620	20,905	(D)	(D)	1,712	(D)	(D)	3,823
5,000 to 9,999.....................…………..........		14,053	536	13,517	(D)	(D)	639	(D)	(D)	2,738
10,000 to 24,999.................……………........		24,876	(S) 955	23,921	(D)	(D)	2,106	(D)	(D)	4,685
25,000 or more...................………..............		73,055	18,253	54,802	(D)	(D)	1,090	(D)	(D)	4,293

See explanatory information and SOURCE at end of table.

Table B-6. Funds for performance of industrial basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry, by size of company, and by source of funds: 1998

Industry and size of company	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[In millions of dollars]						[Percent]		
Distribution by industry:										
All industries...…......		95,912	11,337	84,575	39,217	9,498	29,718	23	39	20
Manufacturing......…..........................…...........		64,875	8,814	56,061	31,926	7,607	24,319	27	42	24
Food, kindred, and tobacco products…..............	20,21	972	0	972	136	0	136	8	0	8
Textiles and apparel..........................…............	22,23	(D)	(D)	(D)	(D)	(D)	(D)	18	(D)	(D)
Lumber, wood products, and furniture.................	24,25	(D)	(D)	250	33	0	33	9	0	9
Paper and allied products..................................	26	(D)	(D)	303	(D)	(D)	(S) 957	61	100	60
Chemicals and allied products...........................	28	(D)	(D)	10,985	(D)	(D)	2,764	(D)	(D)	13
Industrial chemicals......................................	281–82,286	(D)	(D)	3,061	(D)	(D)	872	13	1	13
Drugs and medicines.....................................	283	6,585	0	6,585	(D)	(D)	1,754	(D)	(D)	14
Other chemicals...	284–85,287–89	(D)	(D)	1,338	138	0	138	(D)	(D)	6
Petroleum refining and extraction.......................	13,29	(D)	(D)	(D)	(D)	0	(D)	(D)	0	(D)
Rubber products..	30	977	0	977	305	0	305	(D)	(D)	19
Stone, clay, and glass products..........................	32	294	(D)	(D)	(D)	(D)	(D)	9	(D)	(D)
Primary metals...	33	(D)	(D)	(D)	76	(D)	(D)	(D)	2	(D)
Ferrous metals and products..........................	331–32,3398–99	(D)	(D)	235	(D)	(D)	49	(D)	(D)	12
Nonferrous metals and products....................	333–36	94	(D)	(D)	27	(D)	(D)	(D)	37	(D)
Fabricated metal products..................................	34	(D)	(D)	712	(D)	(D)	588	(D)	(D)	38
Machinery..	35	6,904	42	6,862	(D)	(D)	5,225	(D)	(D)	35
Office, computing, and accounting machines.	357	2,881	3	2,878	4,198	0	4,198	47	0	47
Other machinery, except electrical.................	351–56,358–59	4,023	39	3,984	(D)	(D)	1,027	(D)	(D)	17
Electrical equipment...	36	13,822	534	13,287	(D)	(D)	5,992	(D)	(D)	25
Radio and TV receiving equipment................	365	110	0	110	0	0	0	0	0	0
Communication equipment............................	366	(D)	(D)	6,590	(D)	(D)	(D)	32	94	(D)
Electronic components..................................	367	(D)	(D)	3,532	(D)	27	(D)	31	(D)	(D)
Other electrical equipment............................	361–64,369	3,512	456	3,056	314	0	314	7	0	7
Transportation equipment..................................	37	19,062	7,241	11,821	(D)	2,061	(D)	(D)	20	(D)
Motor vehicles and motor vehicles equipment	371	(D)	(D)	7,773	(D)	(D)	(D)	34	1	(D)
Other transportation equipment......................	373–75,379	(D)	(D)	200	(D)	(D)	(D)	37	61	(D)
Aircraft and missiles.....................................	372,376	10,326	6,478	3,848	(D)	(D)	890	(D)	(D)	17

See explanatory information and SOURCE at end of table.

Table B-6. Funds for performance of industrial basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry, by size of company, and by source of funds: 1998

Industry and size of company	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[In millions of dollars]						[Percent]		
Distribution by industry:										
Professional and scientific instruments...............	38	6,848	478	6,370	(D)	(D)	1,583	42	90	16
Scientific and mechanical measuring instruments....................................	381–82	(D)	(D)	2,214	(D)	(D)	969	64	91	27
Optical, surgical, photographic, and other instruments..............................	384–87	(D)	(D)	4,156	(D)	(D)	614	(D)	(D)	10
Other manufacturing industries[1]..........................	27,31,39	1,884	21	1,863	(D)	(D)	173	(D)	(D)	7
Nonmanufacturing……………..…………….....		31,037	2,523	28,514	7,291	(S) 1,892	5,399	15	32	13
Transportation and utilities.....................	40–41,44–49	1,958	398	1,560	243	(D)	(D)	(D)	(D)	11
Communications......................................	48	(D)	(D)	1,408	(D)	(D)	(D)	1	(D)	(D)
Telephone communications......................	481	(D)	(D)	(D)	(D)	(D)	(D)	1	(D)	(D)
Other communications.............................	482–484,489	(D)	(D)	(D)	(D)	(D)	0	(D)	(D)	0
Electric, gas, and sanitary services...............	49	(D)	(D)	(D)	(D)	(D)	(D)	8	(D)	(D)
Other transportation and utilities....................	40–42,44–47	38	(D)	(D)	(D)	(D)	(D)	79	(D)	(D)
Trade..	50–59	(D)	(D)	8,944	(D)	(D)	207	(D)	(D)	2
Finance, insurance, and real estate....................	60–65,67	1,416	0	1,416	(D)	(D)	42	3	100	3
Services...	701,72,73,75–81, 83,84,87,89	(D)	(D)	14,875	(D)	(D)	4,260	(D)	(D)	17
Business services...	73	(D)	(D)	9,765	3,390	84	3,306	22	16	23
Computer and data processing services...	737	9,720	250	9,471	(D)	(D)	3,302	(D)	(D)	23
Other business services.............................	731–736,738	(D)	(D)	294	(D)	(D)	4	(D)	(D)	1
Health services...	80	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Offices and clinics of medical doctors, hospitals, medical and dental labs.......	801,806,807	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other health services.................................	802–805,808–809	39	0	39	0	0	0	0	0	0
Engineering and management services.........	87	5,975	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Engineering, architectural, and surveying..	871	962	(D)	(D)	(D)	(D)	149	(D)	(D)	18
Research, development, and testing.........	873	4,662	551	4,110	(D)	(D)	(S) 210	(D)	(D)	3
Other engineering and management services..........................	872,874	351	(D)	(D)	(D)	3	(D)	(D)	3	(D)

See explanatory information and SOURCE at end of table.

Table B-6. Funds for performance of industrial basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry, by size of company, and by source of funds: 1998

Industry and size of company	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[In millions of dollars]						[Percent]		
Distribution by industry:										
Other services................................	701,72,75–79,81, 83,84,89	701	522	179	69	0	69	7	0	19
Other nonmanufacturing industries[1]......................	07–12,14,15, 161–162,17	1,932	213	1,720	710	62	647	19	12	20
Distribution by size of company: [Number of employees]										
Total.....................……………….....................		95,912	11,337	84,575	39,217	9,498	29,718	23	39	20
Fewer than 500.......…….....................		18,517	1,929	16,588	2,494	157	2,336	8	5	9
500 to 999.............…….....................		3,071	162	2,909	(D)	(D)	401	(D)	(D)	8
1,000 to 4,999.........…….....................		13,622	174	13,448	(D)	(D)	1,921	(D)	(D)	9
5,000 to 9,999.........…….....................		9,339	(S) 264	9,075	1,095	31	1,064	8	6	8
10,000 to 24,999......…….....................		11,789	(S) 677	11,111	(D)	(D)	6,019	(D)	(D)	25
25,000 or more........…….....................		39,574	8,131	31,443	26,803	8,827	17,976	37	48	33

[1] Manufacturing companies with fewer than 50 employees and nonmanufacturing companies with fewer than 15 employees were sampled separately without regard to industry classification to minimize year-to-year variation in survey estimates. Estimates for manufacturing companies in this group are combined with those for companies in "Other manufacturing industries." Estimates for nonmanufacturing companies in this group are combined with those for companies in "Other nonmanufacturing industries."

KEY: (D) = Data have been withheld to avoid disclosing operations of individual companies.
         (S) = Indicates imputation of more than 50 percent.

NOTE: The R&D in this table is the industrial R&D performed within company facilities funded from all sources except the Federal Government. The funds predominantly are the company's own, but also include funds from outside organizations such as other companies, research institutions, universities and colleges, nonprofit organizations, and State governments. Excluded from this table are company-funded R&D not performed within the company (e.g., R&D contracted out to other organizations) and company-funded R&D not performed in the U.S. (e.g., R&D not performed on U.S. soil by foreign subsidiaries or other foreign organizations).

SOURCE: National Science Foundation/Division of Science Resources Studies, Survey of Industrial Research and Development: 1998

SURVEY DEFINITIONS

EMPLOYMENT, FTE R&D SCIENTISTS AND ENGINEERS

Number of people domestically employed by R&D-performing companies who were engaged in scientific or engineering work at a level that required knowledge, gained either formally or by experience, of engineering or of the physical, biological, mathematical, statistical, or computer sciences equivalent to at least that acquired through completion of a 4-year college program with a major in one of those fields. The statistics show full-time-equivalent (FTE) employment of persons employed by the company during the January following the survey year who were assigned full time to R&D, plus a prorated number of employees who worked part time on R&D.

EMPLOYMENT, TOTAL

Number of people domestically employed by R&D-performing companies in all activities during the pay period that includes the 12th of March, the date most employers use when paying first quarter employment taxes to the Internal Revenue Service.

FEDERALLY FUNDED R&D CENTERS (FFRDCS)

R&D-performing organizations administered by industrial, academic, or other institutions on a nonprofit basis, and exclusively or substantially financed by the Federal Government. R&D expenditures of industry-administered FFRDCs were included with the Federal R&D data of the industry classification of each of the administering firms. The industry-administered FFRDCs included in the 1998 survey, their corporate administrators, and location are indicated below.

FFRDCS SUPPORTED BY THE DEPARTMENT OF ENERGY

- Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID, administered by Lockheed Martin Idaho Technologies Co.

- Oak Ridge National Laboratory, Oak Ridge, TN, administered by Lockheed Martin Energy Research Co.

- Sandia National Laboratories, Albuquerque, NM, administered by Sandia Corporation a subsidiary of Lockheed Martin Corp.

- Savannah River Technology Center, Aiken, SC, administered by Westinghouse Corp.

FFRDC SUPPORTED BY THE DEPARTMENT OF HEALTH AND HUMAN SERVICES, NATIONAL INSTITUTES OF HEALTH

- National Cancer Institute (NCI) Frederick Cancer Research Facility, Frederick, MD, administered by Science Applications International Corporation, Advanced Bioscience Laboratories, Inc., Charles River Laboratories, Inc., and Data Management Services, Inc.

FUNDS FOR R&D, COMPANY AND OTHER NON-FEDERAL

The cost of R&D performed within the company and funded by the company itself or by other non-Federal sources; does not include the cost of R&D supported by the company but contracted to outside organizations such as research institutions, universities and colleges, nonprofit organizations, or—to avoid double-counting—other companies.

FUNDS FOR R&D, FEDERAL

The cost of R&D performed within the company under Federal R&D contracts or subcontracts and R&D portions of Federal procurement contracts and subcontracts; does not include the cost of R&D supported by the Federal Government but contracted to outside organizations such as research institutions, universities and colleges, nonprofit organizations, or other companies.

FUNDS FOR R&D, TOTAL

The cost of R&D performed within the company in its own laboratories or in other company-owned or company-operated facilities, including expenses for wages and salaries, materials and supplies, property and other taxes, maintenance and repairs, depreciation, and an

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appropriate share of overhead; does not include capital expenditures or the cost of R&D contracted to outside organizations such as research institutions, universities and colleges, nonprofit organizations, or—to avoid double-counting—other companies.

FUNDS PER R&D SCIENTIST OR ENGINEER

All costs associated with the performance of industrial R&D (salaries, wages, and fringe benefits paid to R&D scientists and engineers; materials and supplies used for R&D; depreciation on capital equipment and facilities used for R&D; and any other R&D costs) divided by the number of R&D scientists and engineers employed. To obtain a per person cost of R&D for a given year, the total R&D expenditures of that year were divided by an approximation of the number of full-time-equivalent (FTE) scientists and engineers engaged in the performance of R&D for that year. For accuracy, this approximation was the mean of the numbers of such FTE R&D-performing scientists and engineers as reported in January for the year in question and the subsequent year. For example, the mean of the numbers of FTE R&D scientists and engineers in January 1998 and January 1999 was divided into total 1998 R&D expenditures for a total cost per R&D scientist or engineer in 1998.

INDUSTRIAL R&D

As used in this survey, R&D is the pursuit of a planned search for new knowledge or understanding of the subject under study. This search may have reference to a specific application (basic research); the acquisition of knowledge or understanding to meet a specific, recognized need (applied research); or the application of existing knowledge or understanding toward the improvement of a present product or process (development). In industry, *basic research* is the pursuit of new scientific knowledge or understanding that does not have specific immediate commercial objectives, although it may be in fields of present or potential commercial interest; *applied research* is investigation toward discovering new scientific knowledge that has specific commercial objectives with respect to products, processes, or services; and *development* is the systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes. The survey covers industrial R&D performed by people trained—either formally or by experience—in engineering or in the physical, biological, mathematical, statistical, or computer sciences and employed by a publicly or privately owned firm engaged in for-profit activity in the United States. Specifically excluded from the survey were quality control, routine product testing, market research, sales promotion, sales service, and other nontechnological activities; routine technical services; and research in the social sciences or psychology.

NET SALES AND RECEIPTS

Dollar values for goods sold or services rendered by R&D-performing companies to customers outside the company—including the Federal Government—less such items as returns, allowances, freight, charges, and excise taxes. Domestic intracompany transfers and sales by foreign subsidiaries were excluded, but transfers to foreign subsidiaries and export sales to foreign companies were included.

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REFERENCES

National Science Foundation (NSF). 1956. *Science and Engineering in American Industry: Final Report on a 1953-54 Survey*. NSF 56-16. Washington, DC: U.S. Government Printing Office.

———. 1960. *Science and Engineering in American Industry: 1956*. NSF 59-50. Washington, DC: U.S. Government Printing Office.

———. 1994. "1992 R&D Spending by U.S. Firms Rises, NSF Survey Improved." SRS Data Brief. NSF 94-325. Arlington, VA.

———. 1995. "1993 Spending Falls for U.S. Industrial R&D, Nonmanufacturing Share Increases." SRS Data Brief. NSF 95-325. Arlington, VA.

———. 1996a. "1994 Company Funding of U.S. Industrial R&D Rises as Federal Support Continues to Decline." SRS Data Brief. NSF 96-310. Arlington, VA.

———. 1996b. *National Patterns of R&D Resources: 1996*. NSF 96-333. Arlington, VA.

———. 1997a. "1995 U.S. Industrial R&D Rises, NSF Survey Statistics Expanded to Emphasize Role of Nonmanufacturing Industries." SRS Data Brief. NSF 97-332. Arlington, VA.

———. 1997b. *Federal Funds for Research and Development: Fiscal Years 1995–97, Volume 45*. NSF 97-327. Arlington, VA.

———. 1998a. "1996 U.S. Industrial R&D: Firms Continue to Increase Their Investment." SRS Data Brief. NSF 98-317. Arlington, VA.

———. 1998b. *Federal Research and Development Funding by Budget Function: Fiscal Years 1996–98*. NSF 98-301. Arlington, VA.

———. 1999. *National Patterns of R&D Resources: 1998*. NSF 99-335. Arlington, VA.

U.S. Bureau of the Census. 1993. "Effects of the 1987 SIC Revision on Company Classification in the Survey of Industrial Research and Development (R&D)." Technical Memorandum. December 6.

———. 1994a. "Comparison of Company Coding Between 1992 and 1993 for the Survey of Industrial Research and Development." Technical Memorandum. November 3. Washington, DC.

———. 1994b. *Documentation of Nonsampling Issues in the Survey of Industrial Research and Development*. RR94/03. Washington, DC.

———. 1994c. *An Evaluation of Imputation Methods for the Survey of Industrial Research and Development*. ESMD-9404. Washington, DC.

———. 1994d. "Evaluation of Total Employment Cut-Offs in the Survey of Industrial Research and Development." Technical Memorandum. November 3. Washington, DC.

———. 1994e. "Reclassification of Companies in the 1992 Survey of Industrial Research and Development (R&D) for the Generation of the 'Analytical' Series." Technical Memorandum. October 25. Washington, DC.

———. 1994f. *A Study of Processing Errors in the Survey of Industrial Research and Development*. ESMD-9403. Washington, DC.

———. 1994g. "Wedging Considerations for the 1992 Research and Development (R&D) Survey." Technical Memorandum. June 10. Washington, DC.

———. 1995. *Documentation of the Survey Design for the Survey of Industrial Research and Development: A Historical Perspective*. Washington, DC.